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INFANT FEEDING

BY

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FOURTH EDITION, THOROUGHLY REVISED

PHILADELPHIA AND LONDON

W. B. SAUNDERS COMPANY

1922

MADE IN U. S. A.

PRESS OF
W. B. SAUNDERS COMPANY
PHILADELPHIA

PREFACE TO FOURTH EDITION

Following the war, there has been a flood of publications in the pediatric literature due to renewed activity on the part of scientific workers and to the publication of work which had been done previous to or during the conflict. It has been the endeavor of the author to cover the literature up to April 1st, 1921. It has been impossible to draw definite conclusions from much of these data and, consequently, the results of these researches have been stated and in large measure, no comment made. The period in question has represented a definite advance in American Pediatrics, with the corresponding decline in European publications. The most outstanding publications have been those of Marriott in his investigations of intoxication and decomposition, and the rather involved system of Infant Feeding devised by Pirquet. The work of the former has great promise, though as yet it would be impossible to predict whether his ideas will be finally accepted or not. As to the latter, it will require some time to demonstrate the practicability of Pirquet's method.

I wish to acknowledge the assistance of Dr. B. E. Bonar in the compiling of tables and in other ways aiding preparation of this edition.

Clifford G. Grulee.

Chicago, Illinois,
January, 1922.

PREFACE

In preparing this small volume the writer has endeavored to do two things: first, to bring our knowledge of the scientific processes which underlie infant feeding up to the present, and, second, to put forth the practical application of these principles in such a way that they can be grasped by one no more familiar with the subject than the practising physician. In doing this he has met with many difficulties and doubtless has fallen far short of his original intentions, but he trusts that the suggestions here made will be found to be simple and yet conform to scientific principles. To one who is familiar with the general trend of pediatric thought in America these views may seem somewhat at variance with the opinions held by some of the leading American writers on the subject, but the views herein expressed not only are substantiated by the personal observations of the writer, but are confirmed by the experience of the leading Continental physicians.

The book is based on a course of lectures given to the students of Rush Medical College for the past three years, and it is partly due to the demand of these students that the present treatise has been written.

The writings of Finkelstein and the book "Ernäh-

rung, Ernährungsstörungen und Ernährungstherapie des Kindes," by Czerny and Keller, have been freely consulted. The chapters on Physiology of the Gastro-intestinal Tract and Absorption and Metabolism have been written with free reference to the following writers: Meyer, "Ernährungsstörungen und Salzstoffwechsel beim Saügling-Ergeb. d. inn. Med. u. Kinderheilk.," 1908, i, 317; Uffenheimer, "Physiologie des Magen-Darmkanales beim Saügling und alteren Kind.," ibid., 1908, ii, 271; Orgler, "Der Eiweissstoffwechsel des Saüglings," ibid., 1908, ii, 464; Freund, "Physiologie und Pathologie des Fettstoffwechsels im Kindesalter," ibid., iii, 139.

In the discussion of milk, Bulletin 41 of the Hygienic Laboratory Reports of the U. S. Department of Agriculture has been freely consulted.

The classification of nutritional disturbances, though in the main that of Finkelstein, differs from the original in that the weight disturbance is somewhat more definitely defined, while decomposition covers a somewhat broader field.

The writer wishes to express his gratitude to Prof. Dr. Clemens von Pirquet for permission to publish the charts portraying the nature and causes of nutritional disturbances, and Dr. Wm. J. Brady for that on the development of the teeth. He is also indebted to Dr. J. B. Sedgwick, of Minneapolis, and to Drs. A. H. Curtis and E. C. Riebel, of Chicago, for reviewing the text, and to his interne at the Cook County Hospital, Dr. E. B. Fowler, for taking many photographs.

The authorities and nurses at Cook County and Provident Hospitals have co-operated in various ways. The

artist, Mr. A. B. Streedain, and his stenographer, Miss Lane, have helped in many ways. He wishes to express his obligation to his wife for much friendly criticism, and to the publishers for their many courtesies.

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Chicago, Ill.,

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INFANT FEEDING

PART I

FUNDAMENTAL PRINCIPLES OF INFANTS' NUTRITION

CHAPTER I

INTRODUCTION

The systematic attempt to place the nourishment of the infant upon a truly scientific basis was first begun by Czerny and Keller when they published their epoch-making book in 1905. Previous to the appearance of this volume, though much scientific and practical work had been done on the nutrition of the infant, it was all more or less fragmentary, and there had been no extended attempt to separate the good from the bad.

When one remembers that approximately one-fourth of all deaths occur in the first year of life, and that of these about 60 per cent. are due to gastro-intestinal disturbances, he begins to realize how very important the proper nutrition of the infant becomes. There is but little question that of the other 40 per cent. of those young infants who die from other causes, many could be saved if gastro-intestinal complications could be avoided. When these

appalling facts confront us, our duty as physicians spurs us to greater efforts to attain such knowledge as will help to save the little ones entrusted to our care.

As in all branches of medicine, the practice of pediatrics, in so far as it relates to infant feeding, must vary according to the materials at hand. Any hard-and-fast rules which presuppose the possession of apparatus or chemical substances which cannot be procured by any physician, reduce the influence of these principles in just so much as these are unattainable. In this way the most simple laws are the best, provided that the end may be attained, *i.e.*, the health of the child.

In the practice of no other branch of medicine is it so necessary that the physician in charge have the complete confidence and co-operation of the patients' attendants, since patience and care are the two things absolutely necessary if we wish to get the best results. Attention to detail over many weeks is frequently necessary to preserve the lives of our small patients, and a clear judgment, exercised constantly, with a proper estimate of the time and trouble involved, are an invaluable aid to the physician who cares for the sick infant.

When we go from the individual to the community, here again the members of the medical profession must exert all their efforts to dispel the dense clouds of ignorance which have so closely surrounded the laity. We must cease to allow the mothers to think that diarrheas are the result of teething, and must show them that if such were true every child would have diarrhea from the sixth to the eighteenth month, if not continuously at least intermittently. We must prove to them that each child is a law

unto itself, and that because Mrs. A's baby, who was fed on condensed milk, is apparently well, that that in itself is no reason for believing that Mrs. B's will be the same. We must let them understand that mothers, for reason of affection, if for no other, never tell of the countless numbers of little ones past recall as the result of unreasonable nutrition.

Babies' alimentary canals vary as much as their dispositions and mental development, and most mothers are intelligent enough to understand this if the fact is only brought to their attention.

The successful combating of infant mortality can only be brought about by the education of the mothers in the essential facts of the science of the nourishment of the infant. In the future, however, there must be facts, and not unproved theories.

The general outline of this work will be as follows: first, a few chapters which relate to the anatomy and physiology of the gastro-intestinal tract, the metabolism of the infant and the bacteriologic flora of the gastro-intestinal canal; second, that most important subject, breast-feeding; third, artificial feeding in health and in gastro-intestinal disturbances; fourth, nutrition of the infant in diseases and conditions other than those affecting the alimentary canal; fifth, a chapter on the psychology of infant feeding. An endeavor will be made to combine the scientific and the practical, a proposition which, on the face of it, seems easy, but which may at times be difficult or impossible because of the lack of scientific explanation for clinical facts.

CHAPTER II

SPECIAL POINTS IN THE ANATOMY OF THE GASTRO-INTESTINAL TRACT OF THE INFANT

Oral Cavity.—At birth the *salivary glands* are well developed, and the cells show in them the particles colored with acid fuchsin, which demonstrate the presence of the active principle of the salivary secretion.

The eruption of the *teeth* is of much interest, mostly because of the etiologic importance ascribed by the laity of this process in connection with summer diarrhea and other allied disturbances. The first tooth erupts usually in the sixth month. It is not a sign of abnormality, however, if the eruption occurs at any time between the fifth and eighth months. The first teeth to appear are, as a rule, the lower incisors, followed, in turn, by the upper incisors and the canines and molars in order, at about the rate of one a month. It is, however, unusual for them to appear at regular intervals. Most often they appear in groups, followed by latent periods. Usually many days or weeks intervene between the time the tooth appears in the gum and the actual penetration of the mucous membrane. In this way it is seen that the process of "teething," as it is viewed by the average layman, is almost a continuous one from about the sixth month to the end of the second year.

Esophagus and Stomach.—The esophagus offers little of special interest from an anatomic standpoint. The epi-

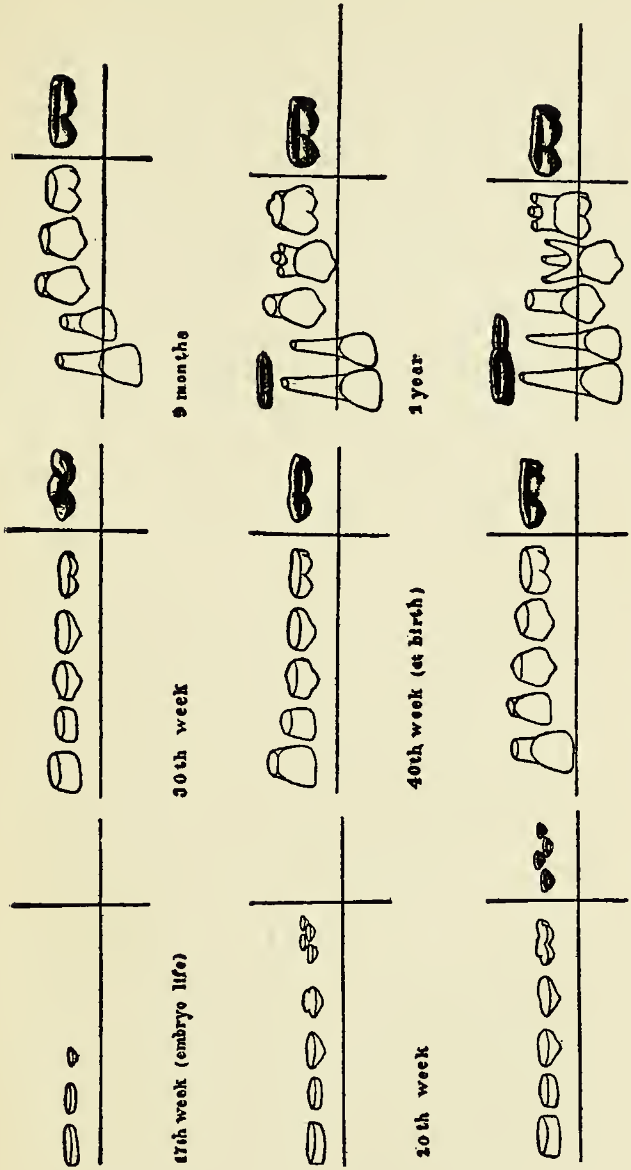

FIG. 1.—Development, eruption, and absorption of the teeth (William J. Brady, D. D. S.).

thelium is soft and delicate, the papillæ are few and small. Glands are usually lacking.

At birth the stomach is in form and position midway between the tubular type of fetal life and the pouch-like organ of the adult. It is nearly horseshoe in shape, with convexity directed toward the left, the whole completely covered anteriorly by the liver. By *x*-ray examination Major[1] has determined that in erect position the form of the stomach is that of a reversed retort, and that respiratory movements of the diaphragm produce changes in the position of the stomach which are very similar to peristalsis.

Age		Length in centimeters	Absolute					Relative		Mode of nourishment in the first half-year of life
			Capacity of the stomach with an internal pressure							
			0	5	10	20	30	0	30	
Yrs.	Mos.		Cubic centimeters of water							
0	0	16.0	20.0	28.0	29	30	32	0.56	0.781	
0	0	16.3	1.8	4.8	6	8	8	0.04	0.185	
0	0	14.5	1.5	10.0	16	19	23	0.05	0.754	
0	¼	14.3	9.0	20.0	33	50	60	0.31	2.052	Artificial.
0	¼	16.7	8.0	21.0	34	59	76	0.17	1.632	Breast.
0	¾	17.3	40.0	88.0	110	160	180	0.77	3.476	Artificial.
0	1	15.3	25.0	20.0	34	68	110	0.42	3.071	Artificial.
0	1	17.0	17.0	63.0	94	137	161	0.35	3.277	Artificial.
0	1¼	17.9	28.0	85.0	103	130	150	0.49	2.615	Breast.
0	2¼	16.7	20.0	54.0	79	114	150	0.43	3.221	Breast.
0	3	17.5	15.0	44.0	60	88	114	0.28	2.687	Artificial.
0	3	19.3	3.5	11.0	17	55	110	0.05	1.530	Artificial.
0	3¾	16.3	15.0	44.0	68	124	192	0.35	4.433	Artificial.
0	6¾	21.0	20.0	93.0	134	210	259	0.22	2.797	Breast.
0	7	25.0	60.0	175.0	255	355	416	0.38	2.662	Artificial.
0	8	19.5	16.0	76.0	150	205	245	0.22	3.304	Artificial.
0	11	22.7	33.0	90.0	150	310	460	0.28	3.933	Artificial.
0	12	20.3	10.0	33.0	51	280	380	0.12	4.542	Breast.
1	2	23.0	35.0	106.0	180	400	530	0.29	4.356	Breast.
1	5	24.6	45.0	65.0	73	80	150	0.30	1.008	Artificial.
1	10	28.5	31.0	80.0	122	210	300	0.14	1.296	Breast.
2	...	26.2	28.0	120.0	253	410	490	0.16	2.725	Artificial.

[1] Zeitschr. f. Kinderheilk., 1913, viii, 340.

The musculature is of varied thickness. The mucous membrane varies in no essential way from that of the adult, except that the gland cells are fewer, which anatomic fact accounts for the relatively smaller amount of gastric secretion in the infant. The capacity of the stomach is a matter of much clinical importance, but one which is not easily determined with any degree of accuracy.

The table of Pfaundler's on page 22 is taken from Czerny-Keller, Bd. i, 48. From this may be seen the extreme variation in the capacity of the stomach under different conditions, part of which may be accounted for by the variation in the amount of resistance to distention of the organ because of the difference in the thickness of the musculature. For practical purposes the capacity given by Holt is of sufficient accuracy:

At birth	1½ to 2 ounces.
At three months	4½ ounces.
At six months	6 ounces.
At one year	9 ounces.

Scammon[1] has shown that the average capacity of the stomach reckoned in cubic centimeters when the organ is under 15 c.c. water pressure may, from the 4th week to the 8th month, be determined by the formula $C = 90 + 5\ N$. In the formula C = stomach capacity and N = the age in weeks.

Scammon and Doyle[2] found the stomach capacity at birth to average 33 c.c.; this increased one-third in 3 to 4 days and more than doubled in the second week.

Thiele[3] states that the size of the infant's stomach does

[1] Am. Jour. Dis. Child., 1919, xvii, 395.

[2] Am. Jour. Dis. Child., 1920, xx, 516.

[3] Zeitschr. f. Kinderheilk., 1917, xv, 152.

not depend upon the quantity of nourishment but upon the amount of air swallowed.

Deserving of note in this connection is the so-called "*systolic contracture*" (Pfaundler) of the stomach. At autopsy the stomach is not rarely found in a contracted condition, with the pylorus hard and nodular. The condition at the pylorus may lead one to suspect a congenital stenosis, but on further examination it will be seen that the enlargement in the "systolic contraction" is almost spheric, and readily disappears with the distention of the stomach, whereas the tumor in a pyloric stenosis is oblong, and does not disappear when the stomach contains fluid. (See Congenital Pyloric Stenosis.)

Intestines.—The intestinal glands and villi of the newborn are well developed. The secretory glands are seen strewn among the mucous glands as far as the descending colon. The elastic tissue is relatively small in amount; this may have some etiologic bearing in those cases of constipation with accumulation of gas and distention. The elastic tissue in these cases probably does not lend sufficient aid to the circular muscle coat.

In the infant there is relatively less difference in the proportional diameter and length of the large and small intestines. This has been thought to have some relation to the more frequent occurrence of intussusception in infancy. Robbin[1] found the length of the large intestine to be 80 to 130 per cent. of the body length in 90 per cent. of his cases and that of the small intestine 500 to 900 per cent. in 80 per cent. The sigmoid is relatively larger and more mobile and its position in the abdomen is much more varied.

[1] Am. Jour. Dis. Child., 1920, xix, 370.

Its mobility and varied position is largely due to the fact that the mesosigmoid is longer and more elastic. According to Kleinschmidt[1] the sigmoid in infancy is frequently found on the right side.

The pancreas shows no special anatomic features.

In the infant the liver is relatively much larger than in the adult. Harley[2] gives the following table of the proportion of the liver weight to the body weight at different periods of life.

In the newborn	1 to 18
In childhood	1 to 20
At the time of puberty	1 to 30
In the adult	1 to 35
In middle age	1 to 40
In old age	1 to 45

From these proportions the approximate weight of the liver may be ascertained. On examination of the newborn the liver may be felt in the nipple line ½ to ¾ inch below the costal margin.

In the newborn child the bile capillaries are found unchanged, but in the children dead in the first few days of life they are found to be tortuous and distended, showing here and there small bulgings of the wall (Knopfelmacher).[3] The bile in these children shows a viscidity greater than in the older infants. According to Knopfelmacher these findings are the result of a venous stasis, which accounts for the icterus neonatorum.

[1] Ergeb. d. Inn. Med. u. Kinderheilk., 1912, ix, 318.

[2] Quoted by Czerny and Keller, Bd. i, S. 67.

[3] Jahrb. f. Kinderheilk., 1908, lxvii, 51.

CHAPTER III

PHYSIOLOGY OF THE GASTRO-INTESTINAL TRACT IN THE INFANT

Oral Cavity.—The *salivary secretion* is present immediately after birth, but at that time consists almost altogether of mucus devoid of potassium sulphocyanid. The reaction is neutral or weakly alkaline, but soon after the ingestion of milk becomes acid, due to the splitting of milk-clots by the bacteria.

Just after birth the suckling of the child is reflex, and is carried on principally by the pressure of the gums against the ampullæ of the lactiferous ducts, the nipple being held in a trough formed by the tongue pressed against the hard palate. Later in the lactation period this primary suckling effort is seconded by the voluntary inspiratory act.

In examining the composition of the fat in the cheeks Lehndorff[1] found that it was poor in fatty acids and hence not easily assimilable. This would account for the fact that in many emaciated children which have not reached the last stages of marasmus, but in which the other fat of the body is almost lacking, the fat in the cheeks still remains. This fat "polster" may show very distinctly in thin young infants as a small pad in each cheek.

For many years past, in spite of the protests of enlightened members of the profession, the physiologic process of

[1] Jahrb. f. Kinderheilk., 1907, lxv, 286.

Fig. 2.—Fat pad in cheek (Saugpolster).

"cutting teeth" has served as the explanation for almost all of the disturbances of infancy, especially of summer diarrhea and convulsions. Though we must admit that a large part of the etiology of the two conditions named is as yet unknown to us, still one can hardly regard this as sufficient reason to blame their occurrence on a perfectly normal process through which every child must go. As has been previously shown, "teething" is almost a continuous process from the sixth month to the end of the second year. The mere fact that teething and diseases of early infancy, notably summer diarrhea and convulsions, occur contemporaneously should not lead us astray in our diagnosis.

There is nothing in the anatomic relations of the teeth which can, in even a remote way, lead to the suggestion of a connection between the teeth and the intestines. "Reflex action" has been advanced as a theory of the mode of action of this process, but for this no facts have been given in support.

On the other hand, it is not unreasonable to think that the cutting of teeth may be accompanied by pain, since it is known that in the adult the appearance of the third molar teeth sometimes brings with it a certain amount of ache in the alveolar processes. That pain is present in all cases is certainly not true, since some babies cut their teeth without any manifestations of discomfort. As to others, the most that can be said is that apparently just before the teeth pierce the gums they seem to be in much pain, which is sometimes relieved by pressure on the gums.

During the time when the teeth are about to pierce the mucous membrane there is often an increase in the amount

of the salivary secretion, which is shown by the drooling of the child.

Stomach.—The *motor activity* of the stomach in the infant is of much importance because of its relation to vomiting and to the length of the interval between feedings. The work of Cannon on animals can probably serve as a basis for our knowledge of the opening and closing of the pylorus, which is the most essential factor in the motor activity of the organ. From Cannon's findings we may deduce that an acid reaction of the contents of the pyloric region of the stomach causes opening of the pylorus, while an acid reaction in the duodenum causes it to remain closed. After the coagulation of the milk in the stomach the contents consist of whey and curds. The former is readily acidified and, therefore, passes the pylorus first, together with any added carbohydrates which happen to be present. The protein requires a longer time, since the acid of the stomach is combined, and hence a certain time elapses before free acid is present. The fatty acids and neutral fats are the last to pass the pylorus, not because they do not easily acidify, but because it takes much longer for the fatty acids to be neutralized by the duodenal juices, and hence the pylorus remains closed because of duodenal acidity. We readily see, then, that a high fat-content of the food delays its passage through the pylorus. Extreme dilution acts in the same way, probably because of the slight stimulation of the gastric mucosa, resulting in reduced secretion and, hence, acidity. The stomach is emptied much more quickly in the breast-fed infant, the average being two to three hours (Theile[1]). The time varies with the amount taken. As to cows' milk, the same restric-

tions must be made, but in the majority of cases the food leaves the stomach only after three to four hours (Theile[1]). These conclusions are not absolutely reliable because of our methods of estimation. Up to the present time two methods have been employed for determining the length of time the food remains in the infant's stomach. To the first of these, gastric lavage, may be objected that all food cannot be removed in this way, and hence the length of time that the food remains in the stomach cannot be accurately determined. The second, by means of the bismuth meal and the *x*-ray, has recently been studied by Pisek and Lewald,[2] Ladd,[3] and Major.[4] The findings in general point to a distinct individual difference in the length of time that food remains in the stomach. To this method may be objected that the bismuth adds a substance which is not normally present. In general it may be said, however, that the statement that food is found in breast-fed infants, under ordinary conditions, usually at least two hours after feeding, and in artificially fed three hours, is correct. However, individual cases may vary greatly from this general rule. Carlson and his co-workers[5] have found that hunger waves appear in the stomach of the infant two and one-half to three hours after the ingestion of food. They state that these probably indicate that that organ is ready to receive food. It should be noted, however, that the presence of hunger waves does not indicate an empty stomach.

[1] Zeitschr. f. Kinderheilk., 1917, xv, 152.
[2] Amer. Jour. Dis. Child., 1913, vi, 232.
[3] Ibid., v, 345.
[4] Zeitschr. f. Kinderheilk., 1913, viii, 340.
[5] The Control of Hunger in Health and Disease, Chicago, 1916.

Taylor's[1] observation as to the time of the appearance of hunger contractions agreed essentially with those of Carlson. Hunger contractions were found by him in premature infants and in certain pathological states (myxedema, typhoid fever). Successive sucking movements are present during the hunger state but in normal breast-fed infants hunger is not ordinarily an immediate cause for crying. Inhibition of hunger contractions may be psychic (from the mouth) or reflex (from food in the stomach).

Hess[2] by using bismuth pills found that large objects pass through the pylorus more quickly than small, and that passage is delayed if the infant is on the left side and hastened if on the right.

This was confirmed by DeBuys and Henriques[3] who also found that the supine position produces a comparatively slow motility.

In the stomach of a four months' fetus there is digestive activity, rennet is nearly always present, as is also pepsin, if there is any acidity. The acidity of the gastric juice is due to several substances: first, to HCl and HCl-albumin bodies, albumose and peptone; second, to lactic acid; third, to fatty acids; fourth, to phosphoric acid, acid phosphates, and the inorganic acid bodies formed by action of HCl on the salts; and fifth, to other acid substances in human milk. According to Davidsohn,[4] hydrochloric acid in the infant's stomach shows no real difference from that of the adult, variations being due to difference in choice of test-

[1] Am. Jour. Dis. Child., 1917, xiv, 233.
[2] Am. Jour. Dis. Child., 1915, ix, 461.
[3] Am. Jour. Ds. Child., 1918, xv, 190.
[4] Zeitschr. f. Kinderheilk., 1912, iv, 208.

meals. Sherman and Johnes[1] in gastric analysis of infants, found values as follows: free HCl 2.20; combined HCl 4.75; total acidity 8.85. According to Hess[2] in the majority of cases there is not sufficient acidity for peptic action while Kronenberg[3] agrees with Davidsohn. According to McClendon[4] the acidity rises slowly after the milk begins to leave the stomach.

The free HCl increases as digestion advances; hence, the longer the interval between feedings the more free HCl is present, and the greater the bactericidal action of the gastric juice. As in the adult, the HCl acts as an aid to peptic digestion, splits the sugars, and, if in sufficient strength (.07 to .08 per cent.), inhibits the production of lactic acid, and acts as a disinfectant. The HCl possesses two other properties which are of much importance to the infant: it is a good detoxicant, being a great aid in the destruction of animal and vegetable toxins, and it also is a good denaturizing agent, which robs foreign albumin of the property of being able to produce antibodies. From the action of HCl and other digestive substances the casein of cows' milk is thus prevented from producing any specific poisons in the infant organism. Hess[5] has found free hydrochloric acid in the stomach immediately after birth in 54 out of 55 cases, in most of them in large amounts. This presents an interesting problem in that the stimulation of the gastric glands cannot be accounted for in the usual way.

The action of *rennet* is the same as in the adult, but not so

[1] Arch. Ped., 1914, xxxi, 749.
[2] Zeit. f. Kinderheilk., 1915, xii, 409.
[3] Jahrb. f. Kinderheilk., 1915, lxxxii, 401.
[4] Jour. Am. Med. Ass'n, 1915, lxv, 12.
[5] Amer. Jour. Dis. Child., 1913, vi, 264.

marked, because of the smaller quantity of the ferment. The casein is coagulated into paracasein, which contains much calcium phosphate. In reality, the clots of cows' milk are probably no larger than those of human milk (although test-tube experiments would tend to show the opposite), since the motor activity of the stomach tends to keep the curd well broken up. Coagulated milk requires less HCl than does uncoagulated. The coagulation is naturally influenced by such factors as the constituents of the food, the dilution, previous heating, and the presence of clots from previous feedings. In respect to the curding of cows' milk in the infants' stomach Brennemann's[1] investigations showed that coagulation begins in a few minutes and the curds increase in size for about two hours when they decrease because of the peripheral digestive action of the gastric juice. The curds of raw and pasteurized milk are large and hard, those of boiled milk small and soft. Dried and condensed milks form a minimum of curd. Increase of the fat content of the food softens the curd but delays the passage from the stomach. Starch decoctions lessen the size of the curd but soluble carbohydrates have no appreciable influence. Alkalies and sodium salts greatly inhibit coagulation. Dilution makes a finer curd. Milk when taken slowly forms a larger curd than when taken rapidly.

Pepsin is frequently present and, according to most writers, splits the protein molecule as far as peptone, but Salge[2] and Hess[3] think that the hydrogen ion concentration

[1] Arch. of Ped., 1917, xxxiv, 81.
[2] Zeitschr. f. Kinderheilk., 1912, iv, 171.
[3] Zeitschr. f. Kinderheilk., 1915, xii, 409.

in the stomach is so slight that pepsin digestion is not possible even in the normal infant. On the other hand, Finizio[1] found that the casein of cow's milk was always digested by the gastric juice of the infant provided this contained free HCl. We are as yet uncertain as to how important for protein digestion the action of pepsin is, but that a certain amount of digestion is carried on by the pepsin is undoubtedly true. There is little difference in its digestive action on cows' and human milk. Like HCl, pepsin acts as a denaturizer.

Lipase, the fat-splitting ferment, is found in the stomach of the infant in small quantities. It is probably a definite product of the gastric mucosa.[2]

The gastric mucosa of the infant is stimulated directly (*e. g.*, by contact with food) but according to Taylor[3] no psychic (*e. g.*, by sucking on the breast or bottle) secretion of gastric juice occurs. The *amount* of the secretion is influenced very much by the character of the food ingested, a proportionately large quantity of fat distinctly inhibiting its formation. The maximum secretion is usually not reached for three hours. Absorption from the stomach is more rapid in the infant than in the adult.

Pancreas.—The pancreas of the newborn contains all the ferments found in the adult, but in much smaller quantity. This is proved by the findings of Lust and Hahn[4] in the stool, and by Hess[5] with the duodenal catheter. Lust and

[1] La Pediatria, 1915, xxiii, 95.

[2] Sedgwick and Schlutz, Amer. Jour. Dis. Child., 1911, ii, 243.

[3] Am. Jour. Dis. Child., 1917, xiv, 258.

[4] Monatsschr. f. Kinderheilk., 1912, xi, 311.

[5] Amer. Jour. Dis. Child., 1912, iv, 205.

Hahn have found all of the pancreatic ferments in the infants' stools examined. The action of the trypsin is completed with the assistance of the erepsin of the succus entericus, and is greatly aided by a strong action of the gastric juice. As in the adult, the end-products of protein digestion are the amino-acids. The steapsin is much weaker than in the adult, but here also its action is aided by the biliary salts. Amylopsin is always present in small quantities, but lactase and invertin are never found in the newborn.

Liver.—The liver possesses the ability to form glycogen and urea in the newborn. Of much importance for the infant is the protection against poisons offered by the liver. This acts on all sorts of poisons, such as toxins of Bacillus coli communis, toxic products from the intestinal canal, as well as upon alcohol and alkaloids, such as morphin and strychnin. Bile is present in fetal life, and possesses the ability to dissolve fatty acids.

The **succus entericus** at birth contains enterokinase, erepsin, lactase, invertin, and maltase.

Lesne, Binet and Paulin[1] in examining the length of time required for the food to traverse the alimentary canal found that this was less the younger the infant and when the food consisted of breast milk. In the breast fed infant the first of the food appeared on the average in about 8½ hours and the entire amount had passed in about 17½ hours. In those infants artificially fed the respective intervals were 10 hours and 21 hours.

The **permeability of the gastro-intestinal wall** is the same as in the adult for the end-products of digestion. It

[1] Arch. d. Med. d. Enf., 1920, xxiii, 449.

is undoubtedly true that in the vast majority of cases albumins cannot pass the gastro-intestinal wall of the infant unchanged, but in certain cases there are idiosyncrasies against cows' or human milk. Although no direct proof offers, there is reason to believe that small quantities of foreign albumin pass through the intestinal wall unchanged and give rise to symptoms of an anaphylactic nature. In nutritionally deranged infants, Lust[1] has recently shown that egg albumin is present in the urine in the severer cases as have Grulee and Bonar[2] in the newborn. Hahn[3] has had much the same results with antitoxin. Lust's[4] results, however, with bovine albumin were not so conclusive. Antitoxic bodies (diphtheria antitoxin) contained in the mother's milk are not absorbed unchanged. It is probable that some highly resistant bacteria, such as the tubercle bacillus (Uffenheimer), pass through the intestinal wall, perhaps enclosed in fat-globules.

Digestive leucocytosis.—It has long been recognized that digestion is accompanied by an increase in the white blood cells. Auricchio[5] has recently called attention to the fact that this increase is preceded by a diminution and that the relation of the two varies greatly in nutritional disturbance. From in vitro experiments he and Caronia[6] came to the conclusion that this increase in white cells is the reaction of the blood following the increase of leucolytic ferment. This latter they found to be most stimulated by proteins espe-

[1] Jahrb. f. Kinderheilk., 1913, lxxvii, 243.

[2] Am. Jour. Dis. Child., 1921, xxi, 89.

[3] Jahrb. f. Kinderheilk., 1913, lxxvii, 405.

[4] Jahrb. f. Kinderheilk., 1913, lxxvii, 383.

[5] La Pediatria, 1920, xxviii, 1093.

[6] La Pediatria, 1920, xxviii, 1129.

cially peptones, less by glucose and fat and not at all by NaCl and KCl.

General Conclusions.—In a general way, then, we see that the infant's gastro-intestinal tract is perfectly able to digest and absorb all food-stuffs, but in relatively less amount than in the adult. When we realize that we have to do with an alimentary system in the formative stage, and that this undeveloped group of organs is called upon not only, as in the adult, to make good the body waste, but also to supply tissue for the formation of the growing body, and that, too, at a time when the body growth is relatively much greater than at any subsequent period of life, we may readily account in large measure for the frequent gastro-intestinal disturbances in the first and second years. Another function not less important is the denaturizing and detoxicant action of the infant's gastro-intestinal tract.

In regard to the fat digestion and absorption, there has been in the past much controversy, caused no doubt, in large part, by the difficulty in differentiating accurately in the stools the various forms of fat. The report of Usuki[1] is probably most reliable because of the perfection of his technic. He found that about 99 per cent. of the food fat was split by the intestinal juices, and that only 13 to 13.5 per cent. of this was found in the feces. The fat in the normal feces consisted of about 10 per cent. neutral fat, 10 per cent. earthy soaps, and the rest fatty acids.

[1] Jahrb. f. Kinderheilk., 1910, lxxii, 18.

CHAPTER IV

ABSORPTION AND METABOLISM

In considering absorption and metabolism we must bear in mind several things. In the first place, metabolic experiments on infants are based on examination of feces and urine collected, as a rule, during a period of three days. That many clinical facts cannot in this way be adequately accounted for is self-evident. The difficulty and tediousness of these investigations is such that it requires a long time and a well equipped laboratory to do what seems to be a small amount of work. This necessitates basing our conclusions on a comparatively small material, and that, too, in a subject which is notably individual in its character. Be this as it may, metabolic experiments have blazed the trail for the most important of our clinical advances in the subject of infant feeding, and as time adds new facts we are enabled to place a more definite conclusion on those already at hand.

Respiratory Metabolism.—While other substances than O and CO_2 pass in and out of the lungs, the relative importance of these from a metabolic standpoint is usually so slight that for all practical purposes respiratory metabolism means estimation of the respiratory quotient $\frac{CO_2}{O}$. When the energy value of the food is largely in the carbohydrates the quotient approaches 1, since the H is satisfied largely by the O of the carbohydrate of the molecule. On the

other hand, when the fat is to a large extent the energy producing element of the food, the O is used up in combustion and the quotient becomes less than 1; *i. e.*, more oxygen is consumed than is accounted for by the CO_2 given off. The respiratory metabolism is thus a guage of the combustion going on in the body, and its estimation under proper conditions is of great importance in determining the energy metabolism of the infant. Murlin and Hoobler,[1] estimating the energy metabolism of ten infants, two to twelve months of age and varying in nutrition from atrophy to fatness, found that for the sleeping period the average was 2.7 calories per kilo per hour, or 39.7 calories per square meter of surface. The heat production was almost the same whichever way the estimation was made. They say "There seems to be no sufficient reason, however, for estimating the food requirements of infants on the basis of surface area rather than on the basis of weight." Benedict and Talbot,[2] after an extremely thorough investigation, the details of which cannot be given here, found in examining the respiratory metabolism of 37 infants of varying age and condition of nutrition that the energy metabolism varied extremely, and that it could not be estimated either on the basis of weight or surface space.

Talbot[3] in two normal infants estimated that to food energy requirement for basal metabolism one must add for muscular activity in the very quiet infant 15 per cent., for the normally active 25 per cent., and for the extremely

[1] Am. Jour. Dis. Child., 1915, ix, 81.

[2] The Gaseous Metabolism of Infants, Carnegie Institution, Washington, D. C., 1914.

[3] Am. Jour. Dis. Child., 1917, xiv, 25.

active 40 per cent. In addition an allowance of 15 per cent. must be made for excreta and 20 per cent. for growth. He thinks that the infant fed artificially on a high protein diet will require more food as also will those infants whose basal metabolism is higher because of additional energy used up in increased restlessness, crying, fever, etc.

The same observer[1] found that in the newborn infant the respiratory quotient indicated that the glycogen supply of the body was soon used up and that before the breast milk supply was available energy was obtained largely from the body fat. The energy requirement is lower than in older infants and the basal metabolism may be calculated from the following formula – total calories = length $\times$ 12.65 $\times$ body surface.[2]

Jaschke[3] found that in the first month of life the energy quotient was somewhat higher than later.

In two premature infants Langstein and Edelstein[4] found that the basal metabolism required about 83 calories per kilo and that practically all food in excess of this was used in growth.

In an amaurotic idiot Talbot[5] found the basal metabolism to be about 30 per cent. below normal.

Protein Metabolism.—As previously noted in the chapter on physiology the protein molecule is split by the intestinal juices down to amino acids. In all likelihood it is in this form that the protein substance is absorbed, but that

[1] Am. Jour. Dis. Child., 1917, xiii, 495.

[2] Body surface may be calculated by Meeh's formula – body surface $= 12.3 \sqrt[3]{(\text{Body weight})^2}$.

[3] Zeitschr. f. Kinderheilk., 1917, xvi, 1.

[4] Zeitschr. f. Kinderheilk., 1916, xv, 49.

[5] Am. Jour. Dis. Child., 1918, xvi, 39.

larger protein radicles pass the intestinal mucosa is certain. It is likely that the proteoses and peptones are absorbed in small quantities. It has also been shown that albumin unchanged may pass through the intestinal wall.

Hayashi[1] could detect egg albumin in the urine of infants after 15 to 20 grams per kilo weight had been taken. Schloss and Worthen[2] found the intestinal tract impermeable to undigested foreign proteins under normal conditions, but this was detectable when nutritional or gastro-enteric disorders existed. It seems likely that in the first few days of life the intestinal mucosa is more permeable to undigested proteins than later, since Grulee and Bonar,[3] by the precipitin reaction, have found definite evidence of egg albumin in the urine of newborn infants in a large proportion of cases though the quantity ingested was extremely small.

The nitrogenous constituents of the blood have received special attention in the last few years. Utheim[4] investigated the quantity of proteins in the blood of infants. She found that this amounted to between 6 and 6½ per cent. in the normal infant and remained at this level until the tenth or eleventh month, then the quantity began to increase so that at fifteen months it reached about 8 per cent., the same as in the adult. This percentage varied in pathological conditions. In acute diarrhea and vomiting the percentage was increased and there were variations in exudative diathesis and nephritis. The most marked and significant changes, however, were in the premature and

[1] Monatsschr. f. Kinderheilk., 1914, xii, 749.

[2] Am. Jour. Dis. Child., 1916, xi, 342.

[3] Am. Jour. Dis. Child., 1921, xxi, 89.

[4] Am. Jour. Dis. Child., 1920, xx, 366.

athreptic infant in which the percentage in many cases was as low as 4. Since the protein content of the blood is a very accurate index of the water content this reduction in premature infants is to be expected since it is well known that the child in utero contains a very high percentage of water. In athreptic infants this is probably to be explained by the low rate of blood flow.

As to the relation of the albumin and globulin contents Schiff and Roser[1] in two normal breast fed infants found that the globulin was 30 per cent., the albumin 70 per cent. In a normal child but constitutionally reduced though breast-fed the globulin was as low as 10 per cent., and the albumin 90 per cent. In two rachitics the proportion was the same as that just quoted; but in another the globulin was 40 per cent. and the albumin 60 per cent. Therefore, under practically normal conditions, variations are marked, and the rachitic findings are no different than those in normal infants. In infectious processes the globulin content was likely to be very high, while in premature infants and exudative diathesis there seemed to be no variations from normal.

Schloss[2] found that the non-protein nitrogen of the blood in 30 normal infants varied between 23 and 39.1 milligrams per 100 c.c.

In atrophic infants Minsk and Sauer[3] found that non-protein nitrogen frequently exceeded 30 milligrams per 100 c.c., while in a general way their findings in normal infants agreed with those of Schloss. In cases of intoxication Schloss

[1] Monatsschr. f. Kinderheilk., 1920, xix, 15.
[2] Am. Jour. Dis. Child., 1918, xv, 165.
[3] Am. Jour. Dis. Child., 1917, xiii, 397.

found the total non-protein nitrogen to be increased to 57 to 232 milligrams per 100 c.c.

As to the amino acid content of the blood Pettibone and Schlutz[1] found no characteristic or consistent variations from that in adults.

It is probable that while a large proportion of the *urea* in the body is formed by oxidative processes in the liver, it is also just as probable that the formation of urea is one of the characteristics of all living cells.[2] The urea metabolism therefore represents a general process of the whole body. Schloss[3] places the urea nitrogen at 4.9 to 14.6 milligrams per 100 c.c. blood. Minsk and Sauer[4] state that the urea nitrogen forms about 50 per cent. of the non-protein nitrogen. Their figures agree very well with those of Pettibone and Schlutz.

In cases of intoxication Schloss found that the urea content increased 20.1 to 108.2 milligrams per 100 cc., showing that the urea increase approximated in percentage the increase of the total non-protein nitrogen. Schloss states that in that case the urea and non-protein nitrogen signifies the impairment of renal function.

Guidi[5] found that normally the urea content of the cerebro spinal fluid was under 0.5 per cent. and that if it was over 1 per cent. the outlook was rather bad. Of 21 cases of which 10 died the urea content varied between 0.92 per cent. and 2.42 per cent. In only one case where the urea had reached 1.6 per cent. was there recovery.

[1] Jour. Amer. Med. Assoc., 1916, lxvii, 262.

[2] von Fürth, Chemistry of Metabolism, 1916, p. 102.

[3] Am. Jour. Dis. Child., 1918, xv, 165.

[4] Am. Jour. Dis. Child., 1917, xiii, 397.

[5] Riv. di Clin. Ped., 1916, xiv, 513.

Liefmann[1] found the *uric acid* content of the blood of infants fed on a purine free diet was 1.3 to 1.7 milligrams per 100 c.c. Sedgwick and Kingsbury[2] found an increase up to 3.9 milligrams in the newborn infant. This fell off slowly to normal about the 8th to 11th day. There is a general parallelism between the increase of uric acid in the blood and the excretion of this substance and they attribute this increase to the failure of the uricolytic power in the fetal tissues.

Veeder and Johnson[3] found that *creatin* and *creatinin* in the blood of children did not vary essentially in quantity from that of adults. Schlutz and Pettibone[4] found that the *ammonia* content in infants was extremely small.

After all allowances have been made for these various products there is always found in the blood a small quantity of nitrogen, the source of which is unknown. According to Stransky[5] this amounts to 25 to 30 milligrams per 100 c.c. This was found increased in intoxication and also in decomposition and dyspepsia, and a high increase in decomposition offered a bad prognosis. Balint and Stransky[6] found this same remnant of nitrogen increased in the newborn infant.

The nitrogen material of the body is excreted almost altogether in the *feces* and *urine,* though minute quantities are to be found in the expired air and perspiration. For all practical purposes these latter two sources of nitrogen may be disregarded.

[1] Zeitschr. f. Kinderheilk., 1915, xii, 227.
[2] Am. Jour. Dis. Child., 1917, xiv, 98.
[3] Am. Jour. Dis. Child., 1916, xii, 136.
[4] Am. Jour. Dis. Child., 1915, x, 206.
[5] Monatsschr. f. Kinderheilk., 1920, xix, 10.
[6] Jahrb. f. Kinderheilk., 1920, xciii, 210.

The principal sources of nitrogen in the stool are four: nitrogen of the food, epithelial cells, digestive and intestinal juices, especially the mucus, and bacteria. In pathological stools mucus and bacteria probably contain the bulk of nitrogen; in normal stools the bacteria alone. This is more readily shown by the fact that increase of the protein content of the food is not followed by increase of the stool nitrogen independent of whether the food is cooked, raw or sterilized. However, in food rich in starch the stool nitrogen is increased, due no doubt, to increased intestinal irritation. In hunger the nitrogen of the stool is probably increased because of the catabolism of the body proteins.

In examining chemically the *nitrogen content* of infants' feces, Van Slyke, Courtney and Fales[1] found that 50 per cent. to 70 per cent. was in the form of protein and amino acid. These are increased in diarrhea stools. There is some question whether urea is present at all; if so, it is only in small quantities. Gamble[2] found 2 mgms. of urea per gram of dried stool. The ammonia content varies greatly but is increased with high protein food and diarrhea.

Examination of the *urine* gives a much better idea of the internal metabolism of protein. Birk[3] has shown that in artificially nourished infants half of the ingested nitrogen is given off in the urine, while in the infant fed on breast milk only 1/6 to 1/7 is found there.

Von Reuss[4] has found *glycocoll* constantly present in infants' urine in very small quantities.

[1] Am. Jour. Dis. Child., 1915, ix, 533.

[2] Am. Jour. Dis. Child., 1915, ix, 519.

[3] Monatsschr. f. Kinderheilk., 1910, x, 1.

[4] Wien. klin. Wochenschr., 1909, xxii, 158.

Most of the *urea* found in the urine probably comes from the breaking down of the food, though a certain amount is unquestionably due to destruction of body tissue.

Apert, Cambessedes and de Rio Branco[1] have shown the infants' urine is capable of a concentration of urea as high as that of the adult. The total urea excretion in infants is of course much less, even proportionally, than in adults since such a large proportion of the food protein is used in the formation of body tissue. It is subject to the same variations as in the adult and constitutes approximately the same proportion of the nitrogen content, except in the newborn infant where the proportion is lower due to the excessive excretion of uric acid.

In respect to the *uric acid* content of the urine Niemann[2] has found that after the first few days of life it does not differ essentially from that of the adult. It is a well-known fact that the uric acid content of the urine is very definitely increased in the first three to four days of life. This condition, however, rapidly disappears so that the quantity assumes the normal by about the 7th to 10th day. Amberg and Morrill[3] found that in a completely normal breast-fed infant there was always an excretion of uric acid higher than in the adult. This was confirmed by Vogt.[4] Francioni[5] thinks that elimination of uric acid of endogenous origin is due to a disturbance in nutrition or to a constitutional anomaly such as exudative diathesis.

[1] Arch. d. Med. d. Enf., 1920, xxiii, 709.
[2] Jahrb. f. Kinderheilk., 1910, lxxi, 286.
[3] Jahrb. f. Kinderheilk., 1909, lxix, 280.
[4] Monatsschr. f. Kinderheilk., 1909, viii, 57 and 121.
[5] Riv. di Clin. d. Ped., 1915, xiii, 662.

Amberg and Helmholz[1] found a fraction of a per cent. of *hippuric acid* in infants' urine.

Creatinin is normally found in infants' urine according to Amberg and Morrill[2] in quantities somewhat greater than in the adult. Sedgwick,[3] however, in the urine of the newborn, found that the proportion was about the same as that in adults, while in older infants it was somewhat reduced. Vogt[4] found that a rather high percentage of nitrogen came from creatinin but the proportion was not increased in parenteral infection.

Creatin was found more frequently present in the urine of children than in adults by Sedgwick.[5] Gamble and Goldschmidt[6] found that ingestion of small amounts of creatin led to increased urinary output. This was more definitely true in infants than in adults and they suggest that this may be a big factor in creatinuria in infants fed on cows' milk.

Indican in the urine may come either as a derivative from intestinal putrefaction or from a breaking down of body tissues, especially from uric acid. In the newborn infant von Reuss[7] found indican present on the first day of life, more rarely on the second, and more frequently on the 4th. His findings have been definitely confirmed by Bonar.[8] Maccone[9] could find no traces of indican and

[1] Zeitschr. f. Kinderheilk., 1913, ix, 6.
[2] Jahrb. f. Kinderheilk., 1909, lxix, 280.
[3] Jour. Amer. Med. Assoc., 1910, lv, 1178.
[4] Monatsschr. f. Kinderheilk., 1909, viii, 57 and 121.
[5] Jour. Amer. Med. Assoc., 1910, lv, 1178.
[6] Jour. Biol. Chem., 1919, xl, 199.
[7] Zeitschr. f. Kinderheilk., 1911, iii, 12.
[8] Am. Jour. Dis. Child., 1921, xxi, 406.
[9] Riv. di Clin. Ped., 1919, xvii, 1.

ethereal sulphates in the urine of breast-fed infants but in those fed on cows' milk traces were to be found. In young babies this was much lower than in older children. In weight disturbance the excretion was 0.5 to 5 grams daily; while in dyspepsia it amounted to 0.1 to 0.2 gram daily; in decomposition about 0.2 gram of indican were to be found daily, but in the end stages only traces were present. In intestinal infections (intoxication (?) the excretion of these substances was parallel to their clinical course.

Moore's[1] findings in regard to *phenol* excretion in the urine of infants agrees very well with those stated above for indican. He found that in the artificially fed infant the excretion per kilogram was greater than in the breast-fed and that the increase in the number of stools was associated with a decrease in the total phenol output. There seems to be a definite relation between the amount of protein in the food and the phenol excretion in the urine, that is, trebling the protein intake doubles the phenol excretion. Phenol was quantitatively present in the urine of each newborn infant. The average for 19 cases in the first few days of life was 11.2 milligrams. Since phenol was present during the period of starvation he thinks it must originate through autogenous metabolism.

In the infant the excretion of *ammonia* in the urine is subject to frequent and wide variation. The increase of the ammonia output in the urine is much more frequently met with than in the adult. This increase is usually regarded as the effort on the part of the organism to neutralize excess of acid formed in the body. Even in perfectly normal infants the ammonia excretion in the urine is greater

[1] Am. Jour. Dis. Child., 1917, xiii, 15.

than in the adult as has been shown by Amberg and Morrill,[1] and Vogt.[2] This is especially true in those infants who have an outspoken intolerance for milk fat.

As will be seen later practically all nutritional disturbances in infants are accompanied by a definite increase of the ammonia output in the urine. This is especially true in weight disturbances. A very interesting observation is that of Niemann[3] who found that in normal children if fat were added to the food and the carbohydrates withdrawn there was no essential increase in the ammonia excretion, but that in rachitic children with increase of fat and withdrawal of carbohydrates the ammonia excretion was greatly increased.

The amino acids after absorption are unquestionably to a large extent combined into tissue protoplasm, a part, however, being broken down to produce energy. It is usual to estimate the portion retained in the system in the terms of quantity of nitrogen retained. Therefore, when we speak of *nitrogen retention* we mean the difference between the quantity of nitrogen contained in the nitrogenous element of the food and the quantity excreted from the body. Such retained nitrogen represents in all probability, to a large extent, protoplasm increase; while in adults the natural state may be regarded as one of nitrogenous equilibrium, in the infant it is readily seen that health can only be associated with *nitrogen retention*. Of course, for short periods of time a deficiency in nitrogen may occur without causing essential disturbance in health but nitrogen defi-

[1] Jahrb. f. Kinderheilk., 1909, lxix, 280.

[2] Monatsschr. f. Kinderheilk., 1909, viii, 57 and 121.

[3] Jahrb. f. Kinderheilk., 1917, lxxxv, 210.

ciency is not compatible with health over a long period of time either in adults or children.

The question of normal nitrogen retention refers especially to that obtaining in breast-fed infants and, of course, varies greatly with different infants. It is only by comparing other nitrogen foods with breast milk in the same individual that we may derive any idea of the use of protein as compared to the normal. So far as it has been able to be determined, protein of cows' milk is as well taken care of by the infant's metabolic processes as is that of human milk, that is, where like quantities of nitrogen are ingested like quantities are excreted in the feces. It is, however, undoubtedly true that more albumin is excreted in the stools of artificially fed infants than in those of breast-fed. This is due perhaps in part to the ingestion of a larger amount of casein, but in all probability in a larger measure to the increase of albumin products in the stool as a result of greater irritation by cows' milk which favors the growth of intestinal bacteria. These findings have recently been confirmed by Lichtenstein and Lindberg,[1] Howland and Stolte,[2] and Tanaka.[3]

Karge and Peiper[4] have found that even meat protein is well digested and absorbed by young infants. The addition of various food stuffs has various effects upon nitrogen retention. Tanaka found that while the addition of pure casein to breast milk was followed by complete absorption and immediate increase in nitrogen retention that soon the

[1] Jahrb. f. Kinderheilk., 1919, lxxxix, 329.
[2] Jahrb. f. Kinderheilk., 1918, lxxxviii, 85.
[3] Jahrb. f. Kinderheilk., 1918, lxxxviii, 161.
[4] Jahrb. f. Kinderheilk., 1920, xci, 235.

nitrogen retention became poorer. These findings are also confirmed by Howland and Stolte. Such a state of affairs would be expected especially if the body were not completely satisfied so far as the possibility of retaining nitrogen products is concerned.

A high fat content of the food does not save the protein, but if lecithin (organic compound containing phosphorus) be added to the fat it is noted that nitrogen retention is favored. Malt; milk and cane sugar and sometimes starch seem to aid nitrogen retention. If for any reason carbohydrates cause an increased fermentation within the bowel this is likely to result in an increased output of nitrogen in the stool and oftentimes a decreased nitrogen retention.

It is reasonable to suppose that if the body could be observed over a long period the retention of nitrogen would go hand in hand with that of phosphorus and chlorin, but when one confines himself to short periods this is not always the case. For a short period only nitrogen retention may take place, independent of salt retention.

According to Schiff[1] the nitrogen retention may be reduced when the water intake is restricted. His observations however, are too few to allow of generalization.

In summing up we may say therefore that *nitrogen retention* depends to a certain extent upon the character of the food taken, even though this food produces no gastro-intestinal disturbance. This variation, however, is comparatively very slight. As a rule it does not enter into the practical consideration of nutrition.

In the breast-fed baby the nitrogen excretion in the feces and urine increases with age. The retention of

[1] Monatsschr. f. Kinderheilk., 1919, xv, 593.

nitrogen is rather independent of the nitrogen ingested in the healthy baby. In the sick baby the ability to retain nitrogen is reduced until convalescence sets in when it is about the same as in the healthy infant. In younger babies the ability to retain nitrogen in artificial feeding is no less than in the breast-fed but in older artificially-fed infants nitrogen is better retained than in those naturally nourished.

Hoobler[1] found that where the protein constitutes more than 7 per cent. of the total caloric value of the food there was an increased heat production, even if the fat and sugar quantities remained unchanged.

Nassau[2] found that in infants fed on albumin rich food who were not thriving further increase of the albumin content up to 4 to 5 times the normal frequently resulted in weight increase and better health, but such increases were not unaccompanied by intestinal disturbance.

It has always been supposed that in hunger the nitrogen of the stools was proportionately increased because of the breakdown of body protein and that after hunger nitrogen was stored up. Aron[3] found that loss of nitrogen through the urine did not vary essentially and when the child was fed it was practically the same as that reported by Meyer in a case of intoxication and that the loss in the stool was almost nil. These latter findings are certainly contrary to those we would expect.

As to the question of nitrogen retention in the newborn infant there is some difference of opinion. Langstein and

[1] Am. Jour. Dis. Child., 1915, x, 153.
[2] Zeitschr. f. Kinderheilk., 1920, xxvi, 270.
[3] Jahrb. f. Kinderheilk., 1917, lxxxvi, 128.

Niemann[1] found that in the first 5 to 8 days there was a negative nitrogen balance and only after this time was there a slow nitrogen retention. This was ascribed to tissue destruction by Birk[2] who, by feeding colostrum instead of human milk, showed that under normal conditions there is a distinct retention of nitrogen and ash during the first days of life.

The action of protein in internal metabolism is still a matter of investigation. That a food rich in protein is accompanied by a distinct increase in metabolic processes has long been known. Recently Hirsch and Moro[3] have definitely associated albumin and whey with alimentary fever. Whether or not this is due to the action of the protein in internal metabolism or to some process within the intestine is not clear. They do not think, however, that this fever is the same as that which is commonly termed "salt" fever.

It is by no means unimportant what the protein material in the food is. Holt[4] has emphasized the importance of taking into account the amino acid content of the various proteins, and Underhill's work lays stress upon the absolute importance to life of certain of these amino acids. Without tryptophane no food is capable of nourishing the individual and the result is death. Without lysine no growth may be expected. The amino acid content of the casein of cows' milk as given by Underhill[5] is as follows:

[1] Jahrb. f. Kinderheilk., 1910, lxxi, 604.

[2] Monatsschr. f. Kinderheilk., 1910, ix (Orig.), 595.

[3] Jahrb. f. Kinderheilk., 1918, lxxxviii, 313.

[4] Arch. of Ped., 1916, xxxiii, 13.

[5] The Physiology of the Amino-acids, New Haven, 1915.

Glycocoll	0.00
Alanine	1.50
Valine	7.20
Leucine	9.35
Proline	6.70
Oxyproline	0.23
Phenylalanine	3.20
Glutaminic acid	15.55
Aspartic acid	1.39
Serine	0.50
Tyrosine	4.50
Cystine	(?)
Histidine	2.50
Arginine	3.81
Lysine	5.95
Tryptophane about	1.50
Ammonia	1.61
	65.49

Fat Metabolism.—As stated in a previous chapter practically all of the fat is split in the intestinal canal and from 87 to 98 per cent. is absorbed. Holt, Courtney and Fales[1] found the absorption in the normal breast-fed infant to vary between 90.3 and 99.2 per cent. The exact form in which fat is absorbed is as yet not definitely settled.

Much work has recently been done regarding the fat content of the blood. Marriott and Sisson[2] found that the average lipoid content of the blood in infants is about 0.68 per cent., somewhat more than that of the adult (0.59 per cent) as determined by Bloor. They found that the blood fat is independent of the state of nutrition of the infant. In other words, the subcutaneous fat does not necessarily bear any relation to the circulating fat. An infant who is gaining weight will have a higher average blood fat than one who is not gaining. This is especially true in breast-

[1] Am. Jour. Dis. Child., 1919, xvii, 241.

[2] Am. Jour. Dis. Child., 1918, xvi, 75.

fed infants. An infant on a formula containing little or no fat shows a higher average blood fat than in the other group. During complete starvation blood fat figures are relatively high. Cases of acidosis (intestinal intoxication) showed no higher blood fat than that of starving infants.

Cohn,[1] in working with Bang's method, found that the characteristic quantity of blood fat was 0.1 per cent. and that there occurred a definite increase of this amount during the process of digestion which reached its maximum in artificially nourished infants in about three hours and disappeared in five. With breast milk this maximum occurred somewhat later and decreased only in nine hours. He found that this was definitely a characteristic of the fat of these foods since the fat of mother's milk in a mixture with skimmed cows' milk acts as does mother's milk, and that of cows' milk with skimmed breast milk acts as with cows' milk. Oils act similarly to breast milk fat. The increase after cod liver oil and after olive oil is less and the fall after cod liver oil is steeper than after olive oil. The failure of a digestion lipemia after a test meal in which fat is used in sufficient quantities may be regarded as a reaction of a disturbed fat metabolism.

Schippers[2] examining the various fat elements in the blood found that neutral fat in infants was 0.083 per cent., in children 0.101; cholesterin in infants 0.041 per cent., in children 0.034; cholesterin ester in infants 0.152 per cent., in children 0.226 per cent. Phosphatids and fatty acids in infants 0.100 and in older children very variable. In exudative diathesis in seventeen cases the neutral fat was

[1] Jahrb. f. Kinderheilk., 1919, xc, 44.

[2] Jahrb. f. Kinderheilk., 1920, xciii, 151.

0.044 and cholesterin 0.037; cholesterin ester in infants 0.105, and phosphatids 0.123. In only one case out of four was there any digestion lipemia and in this it was only slight.

Strathmann-Herwed[1] found that the cholesterol content of the blood serum in normal naturally- and artificially-nourished infants was normal whether the child took fat poor or fat rich food. The premature offered no exception. In exudative diathesis there was some variation but usually these variations were within normal limits. Hypocholesterolemia was present in anemias and scurvy, and also in the convalescent stage of nourishment disturbances if these were extraordinarily prolonged. In infectious processes there was much variation.

Stefano[2] found that with exudative diathesis in twenty children from 14 months to 7 years the cholesterin content of the blood was normal in four, increased in four, and decreased in twelve. He thinks that this decrease is due to increased elimination. This may have some significance with respect to the lowered resistance in these children. Cannata[3] found the cholesterin content of the blood of 13 children up to 16 months of age to be lower than in the adult. In the newborn and nursling the average was 0.08 to 0.1 per cent. Beumer[4] could find no variation from normal of the cholesterin content of the blood in cases of exudative diathesis and rickets. The variation in normal was between .01 and 0.2 per cent.

[1] Monatsschr. f. Kinderheilk., 1920, xix, 20.

[2] La Pediatria, 1918, xxvi, 1.

[3] La Pediatria, 1915, xxiii, 161.

[4] Monatsschr. f. Kinderheilk., 1919, xv, 581.

Elimination of fat takes place only through the intestines. End products of fat metabolism are not recognizable in the urine as such. It is therefore important to see how much of the fat is retained in the body. Holt, Courtney and Fales[1] in two very important articles have examined the distribution of fat in the *stool* and found the following: In normal breast-fed infants the fat of the stool averaged 34.5 per cent. of the dried weight of the stool and was frequently up to 50 per cent. In the first stools the soap fat represented 57.8 per cent. of the total fat; the average was 43.1 per cent. The neutral fat in the best stools averaged 15.9 per cent., while in the average stool it was 20.2 per cent. There was no constant relation between the percentage of fat in the mother's milk and the percentage of total fat and its distribution in the stool. With an increase of fat intake the total fat percentage and the soap fat in the stool is somewhat increased. In 128 stools from 77 infants artificially nourished, their findings may be tabulated as follows:

	Normal	Constipated	Loose	Diarrhea
Average fat per cent. dry weight stool.	36.2	36.2	.....	40.7
				Diarr. Sev. Diar.
Fat soaps............	72.8	73.8	30.6	12.4 8.8
Neutral fat...........	10.0	10.0	.....	60.0
Free fatty acids.......	17.0	17.0	.....	30.0
Fat retained..........	91.3	.....	.....	58.4

There was no definite relationship between the daily fat intake and the percentage of fat or distribution of fat in the stool. There was also no striking relation between the fat intake and retention except when the intake was abnormally low.

[1] Am. Jour. Dis. Child., 1919, xvii, 241, 423.

Bosworth, Bowditch and Giblin[1] found that of the soap present in the stools of infants, the palmitate represented 76.4 per cent.; the oleate about 23.6 per cent. The stools contain the insoluble calcium soaps. The calcium oleate, however, probably shows a higher solubility in bile at 37°C. than do the calcium soaps of stearic, palmitic and myristic acid. The elimination of calcium soap in the stools increases directly in proportion to the degree of solubility of the calcium in the food.

The findings of Usuki[2] would lead one to think that the soap stool represented a condition not of poor fat absorption but perhaps a disturbance of fat metabolism due to excessive fat absorption. But according to Bahrdt[3] the soap stool is accompanied by decreased absorption of fatty acids. This he thinks is due to the increased peristalsis in the small intestines together with increased excretion of alkali which favors the formation of soap stools in the colon.

Aviragnet and Dorlencourt[4] found that in vitro for the formation of calcium and magnesium soaps it was necessary for the fat to be first transformed into the alkali soap and from alkali soap into those of the earth alkali.

Bahrdt and McLean[5] found volatile fatty acids in appreciable quantities in the stools of breast fed infants, but none in those fed on cow's milk. In diarrheal disorders, however, they are present in increased amount in artificial feeding. They believe that the volatile fatty acids produce increased glandular and intestinal secretion and at the same time

[1] Am. Jour. Dis. Child., 1918, xv, 397.

[2] Jahrb. f. Kinderheilk., 1910, lxxii, 18.

[3] Jahrb. f. Kinderheilk., 1910, lxxi, 249.

[4] Le Nourisson, 1919, vii, 283.

[5] Zeitschr. f. Kinderheilk., 1914, xi, 143.

increased peristalsis. It is possible that the volatile fatty acids in the urine may be derived from the catabolism of fats. Aron and Franz[1] found that volatile fatty acids are present in the infant's urine in small quantities, and the quantity was not influenced by fat-rich nourishment, dyspepsia or intoxication.

The fat of the body is probably used almost altogether as a combustible material. It is stored largely as subcutaneous fat and may be drawn on by the organism when the need requires. It is interesting to note that in examining the fat of the body of the fetus and newborn it is shown to approach in composition that of breast milk fat. (Engel, Monatsschr. f. Kinderheilk., 1909, viii, 618). It slowly loses this chemical composition towards the end of the first year. Naturally the quantity of body fat is most variable. In the newborn the proportion of fat is greater than in the adult; later, however, the fat depends largely upon the assimilation and composition of the food, the fat children being those fed on breast milk or large quantities of cow's milk with full amount of carbohydrates. As we will see later obesity of babies is as much a pathological condition as it is in adults.

Increase of fat in the food tends to lower nitrogen retention. In a general way fat favors the absorption of inorganic materials as a whole but slowly reduces retention of calcium and phosphorus. The addition of fat to woman's milk in breast-fed infants, Lindberg[2] has shown, makes practically no difference in the fat absorption or nitrogen retention from the period when the child was on breast

[1] Monatsschr. f. Kinderheilk., 1914, xii, 645.

[2] Zeitschr. f. Kinderheilk., 1917, xvi, 90.

milk without fat addition. On the other hand, this did produce a reduction in the total absorption of mineral salts. This work is in direct contradiction to former experiments. Southworth[1] asserts that there is a familiar tendency to fat incapacity in infancy and childhood. In this he refers to the fat of cow's milk.

Bardesian[2] in examining the chemical characteristics of fat taken from different portions of the infant's body found that the subcutaneous fat was relatively richer in oleic acid, contained more of the non-volatile fatty acids and had a higher caloric value. The mesenteric fat was less rich in oleic acids, contained more volatile and less non-volatile free fatty acids and had a lower caloric value. The perirenal fat took an intermediate place between these two.

It has long been thought that fat in the food had some relation to the resistance to infection in the infant. Whether or not this is characteristic of the fat itself or a property possessed by one of the vitamines is now a question. From a practical standpoint, however, it is certainly true that infants fed over a long period on a minimum amount of fat or on a food practically fat-free show very little resistance to infection. As has already been stated in speaking of the ammonia in the urine, there is a general tendency in the infant to acidosis. This is practically due to a disturbance of fat metabolism as a result of deficiency of the metabolism of carbohydrates. This is most marked in the more acute nourishment disturbances, but is found in other conditions.

[1] Jour. Amer. Med. Assoc., 1917, lxix, 516.

[2] La Pediatria, 1921, xxix, 157.

Constituents of the Blood

	Gram per 100 c.c.					
	Adult	Infant	New-born	Decom-position	Intoxica-tion	Pre-mature
Protein..........	7.5–8.5	6–6.5[1]	4.5–5.5	....	....	4–5.5
Non-protein N..........	0.022[8] – 0.026	0.0182[8] – 0.0279	0.023[2] – 0.040	0.0193[8] – 0.0584	0.0256[8] – 0.0676	
Amino acid	0.004[17] – 0.005	0.0031[3] – 0.007	0.004[2] – 0.006			
Urea............	0.012 – 0.026[10]	0.0049[7] – 0.0146[8]	0.023[2] – 0.044	0.0061[8] – 0.0370	0.025[7] – 0.1122	
Uric acid.........	0.002[3] – 0.004	0.0013[3] – 0.0017	0.003[6] – 0.004			
Creatin..........	0.005 – 0.009	0.0016 – 0.003				
Creatinin.........	0.001 – 0.002	0.0011 – 0.0016				
NH_3............	0.0001 – 0.0014		0.0002 – 0.0006			
Dextrose.........	0.075 – 0.100	0.095[4]	0.085[4]	....	0.125[4]	
Lipoids..........	0.67[14] – 0.72	0.500[9] – 1.000				
Cholesterin.......	0.210[14] – 0.230	0.100[10] – 0.147	0.080[10] – 0.090			
Fatty acids.......	....	0.36[14]				
Lecithin..........	....	0.29[14] – 0.30				
Water *..........	....	=80–81%[11]	75%[11]	....	78–80%[11]	
Ca..............	0.010[5]	0.010[5] – 0.011				
Mg..............	....	0.002[3] – 0.004				
P...............	0.002[10] – 0.006					
Cl..............	0.592†[12]	0.587[12]	0.392[13] – 0.434	0.475[12]		

Carbohydrate Metabolism.—So far as we know carbohydrates are only absorbed in the form of mono- and disaccharides and of the latter only the maltose is taken up under normal conditions. Under pathological conditions other disaccharides are known to have passed the intestinal wall but up to the present time no carbohydrates of larger molecular size have been shown to have been absorbed either under normal or pathological conditions. It is likely that this absorption takes place in the small bowel almost altogether and probably to a large extent in the upper portion.

Southworth[1] has called attention to the value of dextrin in infants' foods and thinks that we should lay more stress on it as a constituent of the various malt foods. For the digestion of starch the duodenal secretion is of the greatest importance. It is distinctly proved that the intestinal bacteria tend to form acids when there is an appreciable

[1] Arch. of Ped., 1912, xxix, 646.

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* See protein content of blood.
† Calculated as NaCl.
= In first month of life.
[1] Utheim: Am. Jour. Dis. Child., 1920, xx, 366.
[2] Schlutz and Pettibone: Ibid., 1915, x, 206.
[3] Liefmann: Zeitschr. f. Kinderheilk., 1915, xii, 227.
[4] Götzky: Ibid., 1913, ix, 44.
[5] Marriott and Howland: Quart. Jour. Med., 1918, xi, 289.
[6] Sedgwick and Kingsbury: Am. Jour. Dis. Child., 1917, xiv, 98.
[7] Schloss: Ibid., 1918, xv, 165.
[8] Minsk and Sauer: Am. Jour. Dis. Child., 1917, xiii, 397.
[9] Marriott and Sisson: Am. Jour. Dis. Child., 1918, xvi, 75.
[10] Cannata: La Pediatria, 1915, xxiii, 161.
[11] Rominger: Zeitschr. f. Kinderheilk., 1920, xxvi, 23.
[12] Courtney and Fales: Am. Jour. Dis. Child., 1917, xiv, 202.
[13] Cannata: La Pediatria, 1917, xxv, 641.
[14] Bloor: Jour. Biol. Chem., 1916, xxv, 577.
[15] Denis and Talbot: Am. Jour. Dis. Child., 1921, xxi, 29.
[16] Leopold and Bernhard: Am. Jour. Dis. Child., 1916, xi, 432.
[17] Van Slyke and Meyer: Jour. Biol. Chem., 1912, xii, 399.
[18] Folin and Denis: Jour. Biol. Chem., 1914, xvii, 489.
[19] Greenwald: Jour. Biol. Chem., 1915, xxi, 29.
[20] Folin and Denis: Jour. Biol. Chem., 1914, xvii, 387.

quantity of starch in the food. This acid formation is not ordinarily abnormal but may easily increase to a point where it produces symptoms. By the addition of malt to the various meals Klotz[1] has shown that the combination of wheat flour and malt extract is the hardest to ferment and produces the smallest amount of acid, while that of oatmeal and malt extract produces the most.

In the blood the carbohydrates are found in the form of dextrose. Heller[2] found that the reduction values in the blood of infants varied within the normal limits accepted for adults.

Niemann[3] divides infants into two classes with respect to the sugar content of the *blood;* those in which this is under .12 per cent. and those in which it is over. He thinks the first group tends to thrive on a fat-rich and the second on a carbohydrate rich nourishment. The percentage, however, was not an index of the requirements of the child. Cannata[4] found that in the newborn the sugar of the blood was .076 to .100 per cent. This was increased two hours after eating by .020 to .030 per cent. These findings agree very well with those of Sedgwick and Ziegler.[5]

Frank and Mehlhorn[6] examined the glycemic curve under varied conditions. When large quantities of cane sugar were added to the food a marked hyperglycemia was produced which lasted for many hours. This attained its height after one hour and fell irregularly. In most of the

[1] Ergeb. inn. Med. u. Kinderheilk., 1912, viii, 593.

[2] Zeitschr. f. Kinderheilk., 1915, xiii, 129.

[3] Jahrb. f. Kinderheilk., 1916, lxxxiii, 1.

[4] La Pediatria, 1917, xxv, 513.

[5] Am. Jour. Dis. Child., 1920, xix, 429.

[6] Jahrb. f. Kinderheilk., 1920, xci, 313.

cases there was a distinct second wave and only after this did the blood sugar fall to normal. The action of starch was similar but the second wave was not present.

Goetzky[1] agreed in general with the findings of Frank and Mehlhorn as to the effect of sugar and starch. The starch curve, however, according to Goetzky, was prolonged and in the sugar curve after the initial rise there was a marked drop and a second rise. He explains the rise as due to the inability of the liver to take care of the amount of sugar which is suddenly taken into the system. The fall to below the original level is due to the recovery of the liver which, due to the demand upon it, even exceeds this normal function. He found a difference, however, between the reaction of different starches. Flour and barley meal showed no difference. There was an initial rise slower than that of sugar, a slower fall and not so marked followed by a second rise. With oatmeal, however, the glycemic curve was more sustained. If there were a mixture of sugar and starch the curve tended to correspond to that of sugar. The reaction in the premature corresponded to that of other children. There was nothing characteristic about the curves with milk mixtures with cereal water nor those of albumin milk. In intoxication the glycemic curve rose very high and did not fall with the same rapidity as under normal conditions. This he thinks is to be explained by the involvement of the liver in this condition.

In the *stools* of infants sugar is almost never found. If present it is only in minute quantities. The amount of starch in the stool depends upon two factors—the quantity of starch in the food and the age of the infant. The younger

[1] Zeitschr. f. Kinderheilk., 1920, xxvii, 195.

the infant the less ability it has to completely digest starch in large quantities and the more apt is starch under such circumstances to appear in the stool. Cellulose may be found under conditions where it is ingested as in food containing vegetables.

Under normal conditions there are few, if any, characteristic products of metabolism to be found in the *urine,* at least not in sufficient quantities to have much clinical significance.

Greenthal,[1] however, has found that the urine of all normal infants contains a determinable amount of sugar. This amount of sugar depends on the volume of the urine but is directly proportionate to the amount of sugar ingested. In severe nutritional disturbances lactose, galactose (Finkelstein), and even saccharose (von Reuss, Wien. klin. Wochenschr., 1910, XXIII, 123) were to be found in the urine. In a recent publication Schloss[2] states that the reducing substance which he found in increased quantities in the urine of infants with nutritional disturbances, especially intoxication, was in all probability dextrose in every instance. Rietschel[3] has also shown that after a hunger period of two to three days the oral ingestion of a sugar solution produced glycosuria from which he draws the conclusion that there is produced by the hunger period an injury to the epithelial lining of the intestines.

In cases of intoxication Dunn[4] has found that the intravenous introduction of a 6 per cent. solution of dextrose in

[1] Am. Jour. Dis. Child., 1920, xx, 556.
[2] Am. Jour. Dis. Child., 1921, xxi, 211.
[3] Zeitschr. f. Kinderheilk., 1913, vii, 282.
[4] Am. Jour. Dis. Child., 1917, xiv, 52.

the majority of cases showed no glycosuria or only a slight trace.

An interesting finding is that of Nothmann,[1] who, in examining the stools of premature infants (breast-fed), found lactase in every case and in the urine of these same babies by the osazone test was able to detect sugar; however, this was not always present. All of the children did well and made gains in weight without showing any signs of gastro-intestinal disturbances.

Meyer and Stern[2] examined the *galactose* metabolism in infants. Age had no regular influence on the increase or decrease of galactose in the urine. The tolerance in the first and second year varied between 20 and 40 grams. Increase of the excretion of galactose almost always referred to a disease of the digestive tract.

Raimondi[3] found in normal breast-fed infants *glycuronic acid* in the urine in considerable quantities. It is ordinarily less than in the adult. In children on mixed feeding or artificial food it is always diminished. In over-nourished breast-fed infants the quantity is diminished sometimes showing only traces. This diminution may lead to a strong suspicion of dyspepsia.

Sedgwick[4] found *oxalic acid* up to 9 mgm. per day in the urine of newborn infants and considerable quantities in older children.

As Mattill, Mayer and Sauer[5] have shown the glucose tolerance of normal infants is almost the same as of adults,

[1] Monatsschr. f. Kinderheilk., 1909, viii, 377.

[2] Arch. f. Kinderheilk., 1920, lxviii, 241.

[3] Le Nourisson, 1918, vi, 104.

[4] Am. Jour. Dis. Child., 1915, x, 414.

[5] Am. Jour. Dis. Child., 1920, xix, 42.

.8 to .9 gms. per kilo. as detected by Woodyatt's method. In atrophic infants, however, this varied from 1.4 to 1.6 grams. Kahn[1] found the tolerance for dextrose to be very high but that it became rapidly lower at the age of about one and one-half years.

The *internal metabolism* of carbohydrates is the same in infants as in adults since they do not enter into the composition of the body tissues, so far as we know, but only supply energy to the organism. Since Finkelstein evolved his theory of "sugar fever" much has been written concerning the action of sugar in raising body heat. Without further discussion of this subject we may say that it has been shown conclusively that such action of sugar depended either upon the fact that the solutions used were hypertonic or else that they were prepared with water which was not above criticism from the standpoint of bacterial content.

As to the fever produced by the oral ingestion of sugar this offers a very complicated problem and it would be extremely hard to prove that sugar itself was directly the cause of the rise of temperature. Morrill[2] thinks that this toxic alimentary fever is produced by the action of whey combined with sugar.

In the body of infants sugar seems to act greatly like an inorganic salt. It seems to favor the retention of water in the system. This is loosely combined and is probably held in the subcutaneous tissues.

Carneiro[3] showed that by the withdrawal of carbohy-

[1] Jahrb. f. Kinderheilk., 1921, xciv, 15.

[2] Jahrb. f. Kinderheilk., 1918, lxxxviii, 313.

[3] Monatsschr. f. Kinderheilk., 1913, xii, 333.

drates in the normal infant there was distinct loss of weight. This loss in weight was accompanied, however, by loss in nitrogen and salts. A good example of this is in those cases of long over-feeding of sugar, especially in the form of condensed milk. Should one of these children suddenly be taken with intoxication the loss in weight is so rapid as to jeopardize the life of the child. This can only be explained by the loss of a large quantity of water (in the form of solution of salts which is very loosely held in the tissues).

Rosenstern,[1] after examining the metabolic conditions in two infants, comes to the conclusion that sugar together with water, alkali, chlorine and albumin form a ring of nourishment material which increases water retention and that always if one of these constituents is lacking or in insufficient quantities in the food, a weight increase is not possible. Klotz[2] has shown that starches spare the protein and fat and produce a distinct water retention.

Inorganic Salts.—In very recent years the inorganic salts have attracted more and more attention. Mayer[3] estimates that the normal breast-fed infant takes about 140 liters of breast milk in the first six months of its existence, and that with this salts are consumed in approximately the following amounts:

Total ash	120–140 gms.
K_2O	30– 58 gms.
CaO	26– 50 gms.
Cl	24 gms.
Na_2O	10– 12 gms.
P_2O_3	12– 16 gms.
MgO	6 gms.
Fe_2O_5	2– 3 gms.

[1] Zeitschr. f. Kinderheilk., 1918, xviii, 333.

[2] Ergeb. inn. Med. u. Kinderheilk., 1912, viii, 593.

[3] Jahrb. f. Kinderheilk., 1910, lxxi, 1.

The intestine is not only the place of absorption, but also of excretion (in large part) of the inorganic matter, and especially of the calcium. In general, the ideas regarding the action of salts have changed recently. It has been conclusively shown (Jörgenson and others[1]) that the rise in temperature produced by subcutaneous injection of salts is due to the use of distilled water which is not fresh and which probably contains the dead bodies of bacteria. Lövegren[2] had the same results with portal injection of sodium salts as with sugars.

As to oral ingestion of salts, Heim[3] thinks that the fever thus produced is due to the hydropigenous action of the salt, and Schloss[4] thinks that the action of salts is a general and not a specific one and is due to the concentration of the salt itself and the individual predisposition of the subject, thus in the main agreeing with Heim.

Of all the salts probably the most important and, therefore, the most studied are calcium and sodium.

Calcium Metabolism.—There seems to be very little question but that calcium is not only absorbed from the intestines but also excreted through the intestinal wall. For this reason it is extremely hard to estimate what proportion of calcium is absorbed. It is found in the intestinal canal in the form of phosphates, chlorides, carbonates and soaps. It is known that Ca_3PO_4 is almost insoluble and probably not absorbed to a great degree, and it is very likely that calcium is not absorbed in the form of calcium

[1] Monatsschr. f. Kinderheilk., 1913, xii, 386.
[2] Zeitschr. f. Kinderheilk., 1914, xii, 110.
[3] Zeitschr. f. Kinderheilk., 1913, viii, 332.
[4] Zeitschr. f. Kinderheilk., 1911, iii, 441.

soaps. As to the other forms very little definite is known.

Handovsky[1] found no reduction in the calcium content of the blood in the presence of the facial phenomenon.

The calcium content of the *blood* has been dealt with exhaustively in the last few years. Howland and Marriott[2] have pretty well established that normally in the blood of infants there is about 11 mgms. of calcium per 100 c.c. Denis and Talbot[3] have found a great variation in the quantity of calcium in the blood, though this variation was not in normal infants. According to their figures the quantity varies from 1 to 13.5 mgms. per 100 c.c. Stheeman's[4] figures agree with those of Howland and Marriott.

Neurath,[5] using Wright's method, found that the amount of calcium in the blood of newborn and very young infants was very high and remains higher than in the adult throughout the first year.

It has long been suspected that the calcium content of the blood was reduced in cases of infantile tetany or spasmophilia and this suspicion has been confirmed by Howland and Marriott.[6] During the active symptoms they found that the calcium may fall as low as 3.5 mgms. and in 18 cases there was an average of 5 to 6 mgms. That this was a characteristic of infantile tetany seemed to be proved by the fact that other convulsive seizures

[1] Jahrb. f. Kinderheilk., 1920, xci, 432.

[2] Johns Hopkins Hosp. Bull., 1918, xxix, 235.

[3] Am. Jour. Dis. Child., 1921, xxi, 29.

[4] Jahrb. f. Kinderheilk., 1921, xciv, 27.

[5] Zeitschr. f. Kinderheilk., 1910, i, 1.

[6] Quart. Jour. Med., 1918, ii, 29.

showed no such reduction. These findings were confirmed by Jacobowitz.[1]

Holt, Courtney and Fales[2] found that the average absorption of CaO by a healthy infant taking modified cow's milk is .09 gm. per kilogram body weight. The total daily excretion of CaO in the salts ranged from .34 to 1.06 gms. with an average of .7 gm. The average absorption of breast-fed infants was about .06 gm. per kilogram, and the absorption represented about 35 to 55 per cent. of the calcium ingested. To insure the average absorption of .09 gm. per kilogram the intake of CaO should be at least .19 gm. per kilogram; while to insure an absorption equal to the average food of the breast-fed infant there should be an intake of at least .13 gm. of CaO per kilogram. The best absorption of calcium was obtained when the calcium intake bore a definite relation to the fat intake, that is, when the food contained .045 to .060 gm. CaO for every gram of fat and when at the same time the fat intake was ample, not less than 4 gms. per kilogram. Excessive calcium intake did not increase calcium absorption. When the calcium oxide intake was very low, less than .1 gm. per kilogram, the absorption of calcium oxide was less than the normal requirements. The calcium absorption did not seem to be influenced adversely by the presence of calcium soaps. In watery diarrhœic stools there was an increased excretion of calcium. On a mixed diet the absorption of calcium was lower than on a milk diet averaging when the intake was adequate .055 gm. per kilogram.

The average excretion in the stool was .87 gm. They

[1] Jahrb. f. Kinderheilk., 1920, xcii, 256.

[2] Am. Jour. Dis. Child., 1920, xix, 97, 201.

feel that there should be at least .19 gm. of CaO per kilogram weight on a mixed diet. The best absorption under these conditions was when the fat intake exceeded .3 to .5 gm. CaO. Addition of calcium carbonates produced greatly increased absorption but calcium acetate and phosphate had no effect. Cod liver oil increases the absorption of calcium and the substitution of vegetable fats for milk fats did not affect the calcium metabolism in a child taking a mixed diet. The calcium absorption by rachitic infants was much lower than in health and during the recovery from rickets the calcium absorption was higher than normal.

Denis and Talbot[1] found in a few cases of epilepsy there was a low blood calcium; they also found that in pneumonia, both lobar and broncho, and acute bronchitis, a similar reduction in calcium.

The conditions in rickets are somewhat varied and neither Howland and Marriott nor Denis and Talbot could find any regular lowering of the calcium content of the blood in this condition.

Howland and Marriott[2] were able to show that the administration of calcium chloride was followed by an increase of the calcium content of the blood. This was confirmed in one case by Denis and Talbot. Jacobowitz,[3] however, was not able to influence the calcium content of the blood by the introduction of calcium salts by mouth.

Handovsky[4] states also that the calcium content of the

[1] Am. Jour. Dis. Child., 1921, xxi, 29.
[2] Quart. Jour. Med., 1918, ii, 29.
[3] Jahrb. f. Kinderheilk., 1920, xcii, 256.
[4] Jahrb. f. Kinderheilk., 1920, xci, 432.

blood is independent of the calcium content of the nourishment, not only of this but of the calcium balance. This confirms the findings of Neurath[1] who goes further and states that attempts to produce artificial calcium increase in the blood by the introduction of more calcium in the food as a rule resulted not in increased but distinctly decreased calcium content in the blood.

A very interesting observation is that of Orgler[2] who states that calcium soap, especially calcium oleate, was much better dissolved by the blood serum than the calcium phosphate, and that by the addition of cod liver oil there took place an enrichment of blood in calcium. This may explain the effect of cod liver oil in the treatment of rickets.

Much has been written concerning the calcium in the *feces* since most of the calcium is excreted from the intestines. Bluhdorn,[3] and DuBois and Stolte[4] show that there is a distinct relation between the absorption and retention of calcium and the reaction in the large intestines in internal metabolism. This tends to reduce the calcium retention by combining the calcium as calcium phosphate in the bowels; alkali has the opposite effect.

Aviragnet and Dorlencourt[5] found that with putty stools the putrefaction set ammonia free which alkalinized the intestinal content. This ammonia combining with the free fat accordingly formed ammonia soaps which increased the total alkali soap. It was only then that alkali earth

[1] Zeitschr. f. Kinderheilk., 1911, i, 1.
[2] Jahrb. f. Kinderheilk., 1918, lxxxvii, 459.
[3] Monatsschr. f. Kinderheilk., 1912, xi, 68.
[4] Jahrb. f. Kinderheilk., 1913, lxxvii, 21.
[5] Le Nourisson, 1919, vii, 283.

soaps were formed by the double decomposition between the alkali soaps and the alkali earth soaps.

Bosworth, Bowditch and Giblin[1] found that a palmitate is the soap present in the largest amounts in the stools of breast-fed infants (palmitate about 76.4 per cent., oleate 23.6 per cent.); in these stools (fat conspitation) almost all of the soaps are insoluble calcium soaps. Calcium oleate probably shows a higher solubility in the bile than the calcium soaps of stearic, palmitic and myristic acids. According to them, the elimination of calcium soap in the stool increases directly in proportion to the degree of solubility of the calcium present in the food.

Di-calcium phosphate is practically inactive; that is, all of the phosphorus of the calcium phosphate appears in the stool and the phosphorus of the casein appears in the urine. Holt, Courtney and Fales[2] could not determine that the calcium soap stool was accompanied by any increase in the excretion of calcium but found that the largest amount of calcium occurred in the watery stools.

Rothberg,[3] in studying the calcium metabolism of the infant, came to the conclusion that the *retention* of calcium depends upon the process of intermediary metabolism and the digestive action of the intestines. There was apparently no relation between the nitrogen retention and the retention of calcium. Milk fat and carbohydrates might cause a calcium deficiency, the latter less than the former. The amount of calcium in the food influenced retention slightly but sterilization made no difference whatever.

[1] Am. Jour. Dis. Child., 1918, xv, 397.
[2] Am. Jour. Dis. Child., 1920, xix, 97, 201.
[3] Jahrb. f. Kinderheilk., 1906, lxvi, 69.

Orgler[1] states that the nitrogen and calcium deposits did not go hand in hand and the addition of fat to the food in many cases diminished the calcium deposit. Addition of carbohydrates did not effect the calcium retention directly.

Lindberg[2] found that by the addition of fat to the mother's milk in breast-fed babies the calcium retention was most markedly reduced. Sato[3] found that the addition of alkali to the milk in a normal infant had a distinctly unfavorable effect on the retention of calcium. Malt extract alone was beneficial, but malt extract to which a considerable amount of alkali had been added seemed to have a rather unfavorable influence on the calcium balance.

Bosworth and Bowditch[4] came to the conclusion that the reduction of chlorine and phosphorus in the food is followed by a retention of calcium which may have a toxic effect. This calcium is eliminated in the urine in the form of calcium lactate. Both Orgler and Neurath agree that in hunger calcium is not excreted in increased amounts in the intestines but is to be found in the urine in larger quantities.

Hamilton[5] found that in 3 of 4 premature infants there was a very low calcium retention during the first months of life. These children all had craniotabes. In periods where the intake exceeded 200 mgms. the retention was sufficient while in periods where the intakes were lower there was sufficient retention in only one case.

It has been for some time a recognized treatment for

[1] Ergeb. d. inn. Med. f. Kinderheilk., 1912, viii, 142.

[2] Zeitschr. f. Kinderheilk., 1917, xvi, 90.

[3] Am. Jour. Dis. Child., 1918, xvi, 293.

[4] Am. Jour. Dis. Child., 1918, xvi, 279.

[5] Am. Jour. Dis. Child., 1920, xx, 316.

spasmophilia to inject magnesium sulphate subcutaneously and the effect upon the clinical course of the condition has been quite satisfactory, but it is rather startling that Schiff and Stransky[1] have found that by the injection subcutaneously of soluble magnesium salts calcium retention was usually prevented and the calcium excretion through the urine was markedly increased.

In the system calcium is utilized principally for the purpose of forming bone. It is estimated that 99 per cent. of the calcium of the body is to be found in the skeleton. It has also been shown in animals that for other uses in the body this skeletal calcium can be regarded as a reservoir which may be drawn upon in an emergency and where the calcium content of the food is reduced below the requirements of the organism there results a decrease of the bone calcium to meet the other needs of the body. That calcium has other uses in the body is quite evident, especially from finding decreased calcium content in conditions which are associated with increased electrical irritability.

The effect of calcium upon this over-irritation has been shown in many ways. Recently Maggiore[2] has shown by the intravenous injection of calcium chloride that there is a rapid lowering of the electrical irritability which was greatest at three hours and lasted for 12 hours. Brown, MacLachlan and Simpson[3] found that by injection of calcium lactate in doses of 1.25 gms. in cases of tetany there was produced a definite reaction. This disappeared between one and seven hours. The more severe the

[1] Jahrb. f. Kinderheilk., 1920, xciii, 205.

[2] La Pediatria, 1919, xxvii, 129.

[3] Am. Jour. Dis. Child., 1920, xix, 413.

reaction the longer it took for the patient to recover. Such injections, however, were not unaccompanied by alarming symptoms.

Usener[1] has recognized in calcium an agent which may inhibit the vegetative nervous system.

As to the effect of calcium upon water retention there is no evidence to show that such occurs. Calcium in small amounts has little or no action on weight but in large doses causes loss in weight. (Schloss, Jahrb. f. Kinderheilk., 1910, lxxi, 296.)

As to the action of calcium on temperature very little has been found out but what has been done would seem to show that calcium is apyretic in its action or at times may produce subnormal temperature even to the point of collapse. This statement, however, must be modified by relating the experience of Brown, MacLachlan and Simpson, who by the intravenous injection of calcium lactate produced fever.

Stheeman[2] believes that the "status calciprivus" is characterized by adynamic symptoms in the sphere of trophic, nerve and gland activity and designates it the disease of fatigue.

Magnesium Metabolism.—Magnesium like calcium is probably largely absorbed and excreted in the bowel, though it appears in small quantities in the urine. As to in what form it is absorbed little if anything is known. In the blood Denis and Talbot[3] found it in quantities varying from 1 to 5 mgms. in 100 c.c. The figures of

[1] Zeitschr. f. Kinderheilk., 1921, xxvii, 262.

[2] Jahrb. f. Kinderheilk., 1921, xciv, 27.

[3] Am. Jour. Dis. Child., 1921, xxi, 29.

Howland and Marriott[1] were 1.75 to 4 mgms. There was not as with calcium a reduction of the magnesium of the blood in tetany in either of these series of cases. In only one instance was there an appreciable rise above 3 mgms., this occurring in a case of broncho-pneumonia with acute intestinal symptoms (Denis and Talbot).

Birk[2] found that whole milk nourishment gave negative magnesium balance while carbohydrates favor retention as does fat-poor food. Howland and Stolte[3] found only a very slight change in the retention of magnesium by the addition of pure casein to breast milk feeding. It has long been recognized that magnesium had a depressing influence upon the nervous system and acting on this Berend[4] employed an 8 per cent. solution of magnesium sulphate subcutaneously with success in spasmophilia. That this action is purely and simply a repressive action of the magnesium salts is indicated by the experiments of Schiff and Stransky already quoted.

Sodium Metabolism.—The sodium of the food is most frequently in the form of chlorides or carbonates and it is likely that it may be absorbed in either of these forms from almost any portion of the intestines. It is largely excreted through the urine. It is impossible to separate the action of sodium itself from the action of sodium as a salt. This may, of course, be said of the other inorganic substances already studied but it is especially true of sodium. In the blood it is found largely as a carbonate and as such, of

[1] Johns Hopkins Hosp. Bull., 1918, xxix, 235.

[2] Jahrb. f. Kinderheilk., 1907, lxvi, 300.

[3] Jahrb. f. Kinderheilk., 1918, lxxxviii, 85.

[4] Monatsschr. f. Kinderheilk., 1914, xii (Orig.), 269.

course, must be regarded as an alkali with the power of neutralizing acids. Schloss and Harrington[1] found that the plasma bicarbonate of normal infants ranged from 49 to 72 volumes per cent. of CO_2 bound as bicarbonate at O°C. at 760 mgms. barometric pressure. These values are lower than those of normal adults.

Edelstein and Ylppö[2] found that the fetal blood contained more diffusible sodium than the maternal blood. According to Lindberg[3] the retention of sodium is adversely affected by the addition of fat to the breast milk in a breast-fed baby. In hunger Aron[4] found the sodium excretion was essentially less than the potassium in a healthy baby.

The sodium salts, especially of the halogen group, and of these most often sodium chloride, have been rather extensively studied as to their physiologic action. The introduction of 3 per cent. sodium chloride solution by mouth has produced a distinct gain in weight if given in small quantities to normal children according to Nothmann.[5] If, however, it be given in large amounts or to children with gastro-intestinal disturbance, the result is much more likely to be a loss in weight. The former effect is in all probability due to a retention of water with the sodium chloride; the latter to nourishment disturbance caused by an excess amount of this solution. Holt, Courtney and Fales[6] found that subcutaneous injection of normal salt solution in diarrhea, in marasmus, or after protracted vomiting is

[1] Am. Jour. Dis. Child., 1919, xvii, 85.

[2] Zeitschr. f. Kinderheilk., 1920, xxvii, 79.

[3] Zeitschr. f. Kinderheilk., 1917, xvi, 90.

[4] Jahrb. f. Kinderheilk., 1917, lxxxvi, 128.

[5] Zeitschr. f. Kinderheilk., 1911, i, 73.

[6] Am. Jour. Dis. Child., 1917, xiii, 73.

retained to large extent for 2 or 3 days, but in normal children there was great variation.

Meyer and Cohn,[1] after careful study of the action of salts on metabolism, found a parallelism between loss of weight and demineralization of the salts. They could demonstrate no specific difference between sodium and potassium.

Rises of temperature regularly occur in normal breast-fed infants after ingestion of 2 to 5 ounces of a 3 per cent. sodium chloride solution. The height of the fever course is reached in about six hours and lasts 16 to 24 hours. This is not as was formerly supposed a peculiar characteristic of very young babies but is found in infants of a year and over. Behrend and Tezner[2] have shown that in these cases there is a retention of water and salt in the blood. Schloss[3] thinks that sodium fever is due to retention of water in the system. Katzenellenbogen[4] has shown that the hydropigenous action of sodium chloride has no effect on perspiration and thinks that the sodium chloride fever produced by oral administration depends on the concentration of the solution. It has been conclusively shown recently that the so-called sodium chloride fever brought about by the subcutaneous injection of physiologic salt solution does not result when the water is freshly distilled (Samelson, Monatsschr. f. Kinderheilk., 1913, xi (Orig.) 125; Bendix and Bergman, Monatsschr. f. Kinderheilk., 1913, xi (Orig.) 387; Spallicci, Riv. d. clin. Ped., 1918, xvi, 583).

[1] Zeitschr. f. Kinderheilk., 1911, ii, 360.

[2] Monatsschr. f. Kinderheilk., 1912, x, 212.

[3] Jahrb. f. Kinderheilk., 1910, lxxi, 296.

[4] Monatsschr. f. Kinderheilk., 1912, x, 465.

Sodium would seem to have little effect on the nervous system except perhaps in spasmophilia. It is interesting, however, that Nothmann[1] has noted distinct exaggeration of the deep reflexes in his case of "severe chloride intoxication." As to the effect of sodium chloride on the blood Rosenstern[2] could produce no leucocytosis by giving a 1 per cent. solution of sodium chloride by mouth to normal children but in children with gastro-intestinal disturbances there was produced a polynuclear leucocytosis along with the rise of temperature.

Potassium Metabolism.—In what form potassium is absorbed by the intestines we know practically nothing. It is, however, almost entirely excreted through the urine. No exact determinations have, so far as we can find out, been made as to the quantity of potassium in the blood. Edelstein and Ylppö[3] have shown that the fetal blood contains an appreciably greater quantity of potassium than does the maternal blood. Lindberg[4] found that there was no decrease in the retention of potassium when fat was added to the mother's milk in a breast-fed baby. Aron[5] found that in hunger the excretion of potassium in the urine far exceeded that of sodium. Fuhge[6] says that in intestinal metabolism potassium chloride acts as an acid. This is shown by the marked increase of the ammonia content of the urine.

Phosphorus Metabolism.—The fate of phosphorus in the

[1] Zeitschr. f. Kinderheilk., 1911, i, 73.

[2] Monatsschr. f. Kinderheilk., 1909, viii, 9.

[3] Zeitschr. f. Kinderheilk., 1920, xxvii, 79.

[4] Zeitschr. f. Kinderheilk., 1917, xvi, 90.

[5] Jahrb. f. Kinderheilk., 1917, lxxxvi, 128.

[6] Arch. f. Kinderheilk., 1919, lxvii ,291.

organism is of much importance, first, because of the entrance of this into the formation of the protein molecule, and, second, because of the phosphorus present in bone. The absorption of phosphorus varies and is little, if at all, dependent on the amount of phosphorus in the food. The absorption perhaps is favored by certain fat foods as cod liver oil, but this seems to be dependent on the presence of rickets. According to Moll[1] well breast-fed infants have not phosphorus in the urine in sufficient quantities to estimate by our present methods. Peiser[2] found increased excretion of phsophorus and sulphur in albumin milk feeding, but Muller[3] could not corroborate this and found that of all the artificial foods buttermilk alone showed an increase over the others. He regards the phosphorus content of the urine as dependent on other conditions and not on the quality of the food ingested.

Langstein and Niemann[4] in examining the urine of newborn breast-fed infants found that little phosphorus was present on the first day of life and a steadily increasing amount from the second to the seventh day and decreasing to the twelfth day; even then an appreciable amount remained. Aron[5] found increased excretion of phosphorus in hunger. This corresponded with the findings in intoxication. Grosser[6] found that glycero-phosphates when introduced subcutaneously gave the best phosphorus retention.

[1] Jahrb. f. Kinderheilk., 1909, lxix, 129, 304, 450.

[2] Jahrb. f. Kinderheilk., 1915, lxxxi, 437.

[3] Monatsschr. f. Kinderheilk., 1921, xix, 311.

[4] Jahrb. f. Kinderheilk., 1910, lxxi, 604.

[5] Jahrb. f. Kinderheilk., 1917, lxxxvi, 128.

[6] Zeitschr. f. Kinderheilk., 1920, xxv, 141.

Sulphur Metabolism.—Sulphur occurs in the urine in the form of acid or neutral salts; the amount is subject to great variations depending upon the protein content of the food (Freund, Zeitsch f. Kinderheilk., 1900, xxix, 24). The neutral sulphur is not affected by the amount of protein or carbohydrates in the food, but increasing the fat content causes marked increase in the neutral sulphur in the urine. Tobler[1] explains this on Freund's theory that the neutral sulphur in the urine is a derivation of the bile. Freund thinks that the reason for the increased amount of neutral sulphur in the urine of the child with gastro-intestinal disturbance is the destructive processes in the liver. Hunger reduces the amount of neutral sulphur in the urine to a minimum.

Howland and Stolte[2] found that when pure casein was added to breast milk feeding the result was primarily an increased output of sulphur but as the nitrogen retention decreased sulphur was retained in larger quantities.

Chlorine Metabolism.—Of the halogen group chlorine is the only one to be considered in this connection. The effects of sodium, potassium and calcium are practically all obtained as chlorides. It is known that in the watery stool water is excreted with the salt, especially sodium chloride, hence the absorption of chlorine is poor. Schiff,[3] however, could not influence the chlorine balance by increasing the water intake.

Courtney and Fales[4] found that the concentration of

[1] Verhandl. d. Gesellsch. f. Kinderheilk., 1909, 94.

[2] Jahrb. f. Kinderheilk., 1918, lxxxviii, 85.

[3] Monatsschr. f. Kinderheilk., 1919, xv, 593.

[4] Am. Jour. Dis. Child., 1917, xiv, 202.

chlorides in the blood plasma of normal infants was similar to that in adults. Cannata,[1] in 12 newborn infants in the first 24 hours, found that the chlorine content of the blood varied between 0.392 and 0.434 per cent.; in 1 to 5 days 0.392 to 0.460 per cent. with an average of 0.420 per cent. This was a little lower than the figures for adults, 0.450 per cent. Sheer[2] found the chlorine content in infants to vary from .505 to .595 per cent. According to him this is strikingly dependent on the gastric secretion in the sense that when digestion starts with the production of hydrochloric acid the chlorine in the blood sinks quickly and falls with the advance of gastric digestion.

Courtney and Fales found the chloride content in tetany to be somewhat higher than in other pathological conditions but in pneumonia this was unaccountably irregular.

Water Metabolism.—In regard to the water retention Meyer[3] has discovered three classes of cases: First, those in which there was a decrease in weight when the food was concentrated and the weight increased only after the addition of water; second, those where the weight remained the same on a concentrated food and there was an increase after the addition of water; and, third, those in which the addition of water made no difference, but who did well on a concentrated food. He found that the water need decreased with increasing age; that on artificial food the water need was 89 grams per kilo weight in twenty-four hours at the beginning and 80 at the end of the first year, while in breast-fed infants the water need amounted to 134 to 140 grams.

[1] La Pediatria, 1917, xxv, 641.

[2] Jahrb. f. Kinderheilk., 1920, xci, 347.

[3] Zeitschr. f. Kinderheilk., 1912, v, 1.

Klose[1] finds the greatest deposit of water is in the skin especially in pathological conditions. Borrino[2] states that the metabolism of water is more active in the infant than in the adult, because of the greater activity of the lungs and skin. In examining the water content of the skin in relation to the various stools in varied conditions Klose[3] was unable to find any regular relationship. Borrino[4] states that there is greater lability of the water in exudative diathesis and the increase of water retention seems to go hand in hand with reduced immunity. Aschenheim[5] found no regular influence of the water retention of the blood by either spasmophilia or exudative diathesis. There seemed, however, to be a more frequent change between the storing up of these and its excretion than in the normal child.

Borrino[6] in examining the perspiratio insensibilis finds that in newborn infants and nurslings it is somewhat higher than in adults (0.22 gm. per sq. dcm. of skin).

Aschenheim[7] found that the water was retained much better in the first three months of life than later, and that sodium chlorides and carbohydrates, especially milk sugar and maltose-dextrin preparations, showed a distinct water combining function. Ohlmann's[8] conclusions agree with this.

[1] Jahrb. f. Kinderheilk., 1914, lxxx, 154.
[2] La Pediatria, 1916, xxiv, 595.
[3] Jahrb. f. Kinderheilk., 1920, xci, 157.
[4] La Pediatria, 1916, xxiv, 595.
[5] Zeitschr. f. Kinderheilk., 1919, xxiv, 281.
[6] Riv. di Clin. Ped., 1916, xiv, 291.
[7] Zeitschr. f. Kinderheilk., 1920, xxiv, 281.
[8] Zeitschr. f. Kinderheilk., 1920, xxvi, 291.

Wimberger[1] found that the water content of the blood is very constant and to a very marked degree independent of the water content of the surrounding tissues. Rominger[2] agreed with this statement but thinks that in young infants the tendency is less marked and that there is more variation than in adults. He states that the blood concentration reaches its stable stage in the 5th month. He found no essential difference between the water content of the blood in the artificially and breast-fed infants. With liquid food he found a transient hydremia which reached its height in a half hour after the ingestion of the food and gradually receded after 1 to 1½ hours. In intoxication this hydremic reaction runs a very quick course.

Grulee and Bonar[3] have reported a case where the temperature, which could not be explained any other way, was combined with marked concentration of the blood suggesting that the temperature rise was due to dehydration. This has been suggested as an explanation for the so-called inanition temperature of the newborn but the observations of these investigators failed to show any definite evidence.[4]

Vitamines.—Much enthusiasm has recently been aroused by the investigation of substances which have been termed vitamines. These substances, so far as we know, do not have the chemical characteristics of the other food stuffs already described in this chapter. In fact, their chemical characteristics have escaped detection up to the present

[1] Zeitschr. f. Kinderheilk., 1920, xxv, 64.
[2] Zeitschr. f. Kinderheilk., 1920, xxvi, 23.
[3] Am. Jour. Dis. Child., 1921, xxi, 220.
[4] Am. Jour. Dis. Child., 1921, xxii, 44.

time. They are, however, essential to life and growth and are distributed in various ways in the different foods. McCullom[1] has probably conducted more extensive investigations along these lines than has anyone else. "There are two identified dietary essentials and but two dietary deficiency diseases due respectively to a shortage of one or the other substances, fat soluble *A*, and water soluble *B*. The fat soluble *A* is found principally in milk and green vegetables; the water soluble *B* is likewise to be found in milk and green vegetables and is widely distributed in nature, but unlike fat soluble *A*, it is not associated with the fats of the food. It is not to be found, however, in the polished grains but only in those which have not been subjected to the process of removal of the bran layer. Deficiency in water soluble *B* has been very definitely associated with beri-beri. That of fat soluble *A* has led in animals to the production of severe xerophthalmia and a severe state of malnutrition."

It is interesting to note the great parallelism which exists between this condition in animals and that in infants designated by Czerny as "mehlnährschaden." Many further attempts have been made to identify these or similar substances with conditions in infancy. Aron,[2],[3],[4] in various investigations sought to demonstrate a definite relation between extractive substances obtained from cereals and vegetables and the increase in weight in certain cases. His results have been very suggestive but whether or not

[1] "The Newer Knowledge of Nutrition" by E. V. McCullom, New York, 1919, 135.

[2] Monatsschr. f. Kinderheilk., 1916, xiii, 359.

[3] Monatsschr. f. Kinderheilk., 1919, xv, 561.

[4] Jahrb. f. Kinderheilk., 1920, xcii, 82.

such substances may be regarded as vitamines is certainly not yet definitely settled. Heim[1] suggests a like result from the use of malt extract or alcoholic extract of sprouting barley. Daniels and Byfield,[2] and Loughlin[3] think that the failure to gain in infants and young children is often due to a deficient amount of anti-neuritic vitamines (water soluble *A*). They showed that orange juice contained a relatively large amount of anti-neuritic vitamines and that the stimulating action of orange juice was due to this because if its anti-neuritic vitamine were removed there was no stimulation to growth.

Eddy and Roper[4] had some success in the use of what they term pancreatic vitamines in marantic babies.

There has been a great deal of discussion as to the relation of vitamines to infantile scurvy. Many investigations have been carried out by Hess and his co-workers but none of these show conclusive evidence that the vitamine is to blame for this condition.

Hess and Unger[5] could find no evidence that deficiency in fat soluble *A* was the cause of rickets nor that it was indirectly involved.

Von Mysenburg[6] could find no relationship between deficiency in vitamines and increased electrical irritability.

In a recent article Hess[7] has called attention to the various aspects of the vitamine question in the infants'

[1] Monatsschr. f. Kinderheilk., 1916, xiii, 495.

[2] Am. Jour. Dis. Child., 1919, xviii, 546.

[3] Am. Jour. Dis. Child., 1920, xix, 349.

[4] Am. Jour. Dis. Child., 1917, xiv, 189.

[5] Jour. Am. Med. Assoc., 1920, lxxiv, 217.

[6] Am. Jour. Dis. Child., 1920, xx, 206.

[7] Jour. Am. Med. Assoc., 1921, lxxvi, 604.

food and especially as it affects scurvy and rickets. The caution which he advises regarding premature interpretation of experimental results is surely to be commended.

Acidosis.—A few words as to acidosis. In the commonly accepted meaning of the term, the condition is quite widespread in the nutritional disturbances of infants. The recent articles by Howland and Marriott[1] have been most enlightening and have given us an entirely new viewpoint. The ways by which the acid excess is disposed of in the body are three: (1) By the escape of CO_2, from the $NaHCO_3$ of the blood through the lungs, thus leaving the molecule again ready to take up another acid radicle. When the acidosis is marked this accounts for the hyperpnœa, in which condition the CO_2 content of the alveolar air is not high because of the rapid ventilation of the air sacs. (2) By elimination of the acids through the kidneys. (3) Through the action of the proteins or their derivatives. Acidification of the proteins cannot aid greatly in reducing the acid radicles in the circulating blood, but by the destruction of urea, ammonia may be formed. The question now arises as to whether an acidosis is present if the only evidence is the presence of increased acetone, diacetic acid, etc., and ammonia output in the urine. Obviously this does not in itself constitute a condition of the organism in which the acid production is so great as to threaten to overwhelm the economy, and yet it is evidence of an increased production of organic acids in the body and an effort of the body to combat that situation. For this condition it is not so evident that the term acidosis is

[1] Bull. Johns Hopkins Hosp., 1916, xxvii, 63; Am. Jour. Dis. Child., 1916, xi, 309; Ibid, 1916, xii, 459.

appropriate, but it has the advantage of long usage and hence will be retained in this work and the more severe forms be especially taken note of as they arise.

The alkalies in the feces are increased when the fat content of the food is high, possibly due to an increased excretion of the alkalies in the formation of soap in the intestinal canal. There exists in the infant a marked tendency toward acidosis, as is manifested by the frequent appearance of increased amounts of ammonia in the urine. In all probability this acidosis in many cases is not so much a true increase of the amount of acid in the system, as a disturbance of the acid-alkali equilibrium by the withdrawal of the alkalies through the intestinal wall.

Veeder and Johnson[1] found that the quantity of acetone bodies in the urine during the inanition periods varies directly with the duration of the inanition. Torres[2] examined the reaction of the urine in its relation to diet. By diminishing the amount of protein to 2 or sometimes 3 grams per kilo the urine may be rendered alkaline without the use of a drug. In cases where this is not sufficient the addition of vegetables to the diet will still further diminish the acidity. The action of drugs is very fleeting and therefore they must be given in large and frequent doses.

Flamini[3] examined the urine of babies as to the acidity. The acidity was expressed in numbers of c.c. of N/10 NaOH required to neutralize 10 c.c. of urine. In breast-fed infants this varied from .1 to .6 c.c. if the infants were

[1] Am. Jour. Dis. Child., 1917, xiii, 89.

[2] Am. Jour. Dis. Child., 1917, xiv, 365.

[3] Riv. di Clin. Ped., 1917, xv, 462.

normal, while in those with bad stools or diarrhea this was increased to 1.2. In artificially fed infants the figures were .6 to 4 c.c. and the acidity was increased in cases of diarrhea. In breast-fed infants this increase was due to increase of sulphuric acid, while in artificially fed infants the phosphoric acid was accountable.

Ylppö[1] in a monograph has recently described the condition which he regards as an outspoken acidotic state in the newborn. He found that in the newborn either at term or premature the degree of CO_2 regulation of the blood was distinctly higher than in later life. The CO_2 dissociation curve was strikingly lower in the newborn. According to him there is a marked decrease in the degree of CO_2 regulation in hunger and this is more intense in children nourished with cow's milk than in those with breast milk. The urine in hunger is more acid. He states that the acidosis of the newborn can be regarded as latent. Seham[2] has been unable to find any evidence of this acidotic state in the newborn which Ylppö has described.

A much more severe condition is that described by Howland and Marriott in the acute stages of intoxication which is characterized by severe hyperpnœa and which they believe due to a lowering of the ability of the kidneys to excrete acids. They find no evidence of the increased formation of acetone bodies. This last is confirmed by the investigation of Allaria[3] who was able to detect no increase of the acetone content of the brain, muscles, liver or spleen in infants dead of acute diarrhœal diseases.

[1] Neugeborenen—Hunger und Intoxikationsacidosis, Berlin, 1916.
[2] Am. Jour. Dis. Child., 1919, xviii, 42.
[3] Riv. di Clin. Ped., 1915, xiii, 321.

Ylppö[1] has confirmed the finding of acidosis in cases of intoxication, as have also Schloss and Stetson.[2] The latter have been able to overcome the acidosis by intravenous injection of 75 to 150 c.c. of a 4 or 5 per cent. solution of sodium bicarbonate.

[1] Neugeborenen—Hunger und Intoxikationsacidosis, Berlin, 1916.

[2] Am. Jour. Dis. Child., 1917, xiii, 218.

CHAPTER V

BACTERIOLOGY OF THE GASTRO-INTESTINAL TRACT OF THE HEALTHY INFANT

The bacteria found in the alimentary canal of the normal infant may be divided into two distinct classes: the essential organisms and the accidental. The latter are such as are introduced with the food or some foreign substance, as air, and which are to be found usually only in small quantities more or less throughout the gastro-intestinal canal and perhaps even in the feces. Their presence in the lower bowel goes to show that the alimentary canal does not produce antiseptic substance of sufficient power to kill all bacteria, even though these may be introduced into the mouth and pass the entire length of the canal. This has been recently shown by Ford, Blackfan and Batchelor.[1]

Distribution of Bacteria.—Bacteria are to be found in the *mouth* immediately after birth, and within a very short time thereafter in the rectum. The probabilities are that the invasion takes place in both directions, since thirty-six hours after birth bacteria have been found in the jejunum and ileum, even though none were to be found in the duodenum.

Of ccurse, the bacterial flora of the mouth is a more or less varied one. In the newborn infant are found the Bacillus coli, the enterococcus, and Bacillus perfringens.

[1] Am. Jour. Dis. Child., 1917, xiv, 354.

Later, the streptococcus and pneumococcus are frequently found, and after the teeth appear, the fusiform bacteria. The flora of the mouth in incubator babies is richer, due, no doubt, to the more favorable temperature.

The *stomach* is, as a rule, poor in bacteria, but should such enter in large quantities with the food, the antiseptic action of the gastric juice may not be sufficiently strong to destroy them. A most fertile source of infection below the stomach, as a result of the inability of this organ to sterilize its contents, is seen in the large, hard milk-clot, in the center of which bacteria can be included and thus carried into the intestines.

The bacterial flora varies greatly in the *small intestine*, both as to quantity and quality. From the duodenum only an occasional colony can be grown, while in the ileum bacteria are present in large numbers. The reasons for the small number of bacteria to be found in the duodenum are many. In the first place the secretion is sterile and is mixed with a food-content which has already undergone the antiseptic action of the gastric juice; again, the food remains too short a time in the duodenum for bacterial growth; and, again, the intestinal secretion itself is bactericidal in its action.

All investigators agree that the lactic acid bacillus and the colon bacillus are common inhabitants of the small intestine. Sittler, however, thinks that the enterococcus (Streptococcus acidi lactici) is found in greater quantities than either of the others. This would seem to make very little difference so far as their action on the food is concerned. The ileocecal valve seems to mark a distinct dividing line of the bacterial flora, because in the cecum the

number of bacteria is markedly increased, and we here encounter for the first time the anaërobic Bacillus bifidus communis, which organism forms the chief bacterium found in the breast-fed infant's stool; in fact, it occurs there almost to the exclusion of other bacteria. The lactic acid and colon bacilli progressively decrease in number as the rectum is approached. According to Sittler, there is found in the mucus throughout the intestine the Bacillus perfringens. Moro has found the Bacillus acidophilus to be quite constant in the small intestine and the upper part of the large intestine (with this the Bacillus exilis is probably identical). Staphylococci, the motile butyric acid bacillus, intestinal diplococci, and the Bacillus mesentericus vulgatus are also frequently found. Metchnikoff also regards the Bacillus putrificus as a bacterium commonly found in the intestines and feces.

Although the **biologic characteristics** of bacteria on culture-media may not be translated *in toto* to those within the body, still a general idea of their action can probably be so obtained.

A brief résumé of the general characteristics of the more common intestinal bacteria would, therefore, be of some interest.

The Bacillus bifidus communis (Tissier) is an obligate anaërobic bacterium, grown best on sugar-agar. The form is polymorphous, giving rod shapes, rod shapes with branched ends, which may or may not be nodular, containing spores. Sometimes the bodies stain irregularly, showing irregular areas staining deeply (Gram positive), enclosed in an almost clear or slightly staining body (Gram negative). Occasionally we see forms having small deep-

staining areas with large, bulging, non-staining body, which retracts when in salt solution (Moro). (Formes vesiculeuses, Tissier.)

The bacillus has a slow, gliding movement. It grows best on sugar-agar, but is also to be cultivated on sugar-bouillon. No growth on gelatin. It does not change milk, nor is it pathogenic to animals. It is supposed to have a certain putrefactive action and to grow best in a strong acid-medium (*e. g.*, in the colon of the breast-fed infant).

The Bacillus coli and B. lactis aërogenes belong to the same group. Their action is largely the formation of lactic acid, some strains of the colon bacillus forming indol in bouillon culture. Other characteristics of these bacteria are so well known that it is useless to repeat them here. The enterococcus (Micrococcus ovalis, Streptococcus acidi lactici) is a Gram-positive coccus, whose action on milk-sugar is greater than that of the Bacillus lactis aërogenes.

The Bacillus perfringens (anaërobic butyric acid bacillus), as previously stated, is found especially in the mucus of the intestinal wall. It is found there always in its sporogenous state, sometimes in its asporogenous form. In the former state this organism produces putrefaction, while in the latter it splits the carbohydrates into lactic and butyric acids, carbon dioxid, water, and small quantities of alcohol. The Bacillus putrificus, which probably belongs to the same group as the above, produces putrefaction in albumin media. The Bacillus acidophilus has the peculiar property of growing on a highly acid medium (sufficient acid to neutralize like quantities of $\frac{n}{10}$ KoH), independent of whether the acid is mineral or organic. It possesses

the power to coagulate cows', but not woman's, milk. The Bacillus acidophilus is probably rather a group of bacteria than a single organism.

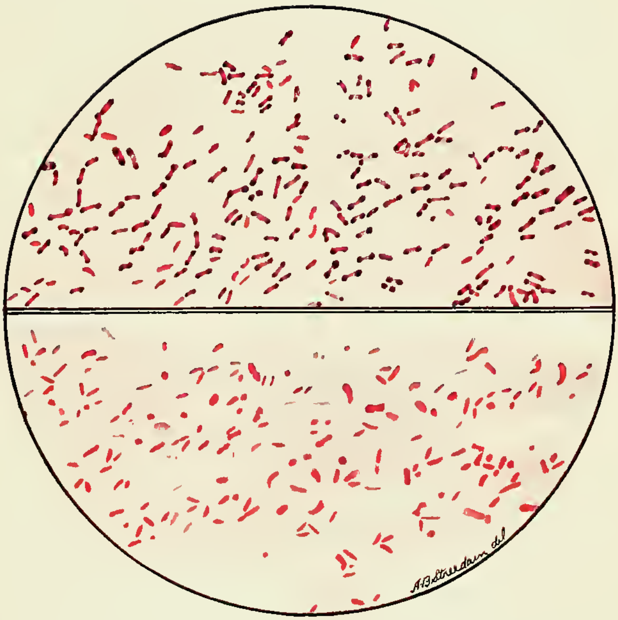
In the stool of the normal breast-fed child the bacteria may form as high as 30 per cent. of the dry residue. Most of these organisms, of course, are dead, but it has been impossible to determine the exact proportion of dead to living because of the different characteristics in culture.

On the smear the breast stool is found to contain a bacterial flora, which is almost altogether Gram positive (due, of course, to the Bacillus bifidus communis), with here and there a Gram-negative bacillus or a Gram-positive coccus.[1] A peculiarly interesting fact is that the stool of the artificially fed infant is almost sure to be Gram negative, while that of a baby on mixed feedings will show gradations between the two. After thorough investigations Bahrdt and Beifeld[2] advance the following very plausible theory in explanation of these facts: On mothers' milk fermentative processes predominate, while on cows' milk putrefaction is stronger. The calcium-content and the curd in cows' milk offer more opportunity for putrefaction, hence the lactic acid production from the milk-sugar is not so great. In mothers' milk the lactic acid production is so great as to inhibit the growth of the Bacillus coli and B. lactis

[1] A very satisfactory stain is Escherich's modification of Weigert's. Solutions: (*a*) Gentian-violet 5 : 200, boil one-half hour and filter. (*b*) Alcohol; anilin oil 11 : 3, mix *a* and *b* in proportion of 17 : 3. Technic: Spread thin and fix in flame gentian-violet solution for a minute, remove with filter-paper, pour on Lugol's solution, and pour off quickly, decolorize with anilin-xylol until no blue color remains, cover with xylol, and dry. Counterstain with concentrated alcoholic solution of fuchsin, wash in water, dry, and examine.

[2] Jahrb. f. Kinderheilk., 1910, lxxii, Erganzungsheft, 71.

PLATE I



Staining characteristics of the infant's stool (× 1600). Stool of the breast-fed infant Gram positive; stool of artificially fed infant Gram negative.

aërogenes (enterococcus (?)) in the lower end of the ileum, while the highly acid medium favors the growth of the Bacillus bifidus communis and the acidophile bacteria.

In the human intestinal tract two antagonistic bacterial processes are active: fermentation and putrefaction.

In the normal breast-fed infant the former predominates to a much greater degree than in the normal artificially-fed infant. Fermentation is present in an acid medium, and is, in all probability, due to the action of the Bacillus lactis aërogenes, B. coli, enterococcus, etc. In the acid medium formed by these bacteria there thrive the Bacillus bifidus communis and the B. acidophilus. The former of these at least has a putrefactive action, so that if there is any putrefaction in the normal infant's intestines it must take place in the colon.

On the other hand, we have to reckon with the Bacillus perfringens, that inhabitant of the mucus which, in its sporogenous form, is putrefactive in its action, and in its asporogenous, fermentative, but which is found in the intestines most in its sporogenous form.

One would conclude ordinarily that, given a food rich in carbohydrates, the pathologic result, if any, would naturally be an excess of fermentation, but is this so? The mucus of the gastro-intestinal tract is, in all probability, the protein from which putrefactive products are formed. This being true, anything which increases the flow of the mucus not only gives a medium in which putrefactive bacteria can work, but also increases the alkalinity (decreases the acidity) of the intestinal content. If the products of fermentation are so irritating to the mucous membrane as to cause an increased flow of mucus, or if the

metabolic products of excessive carbohydrate digestion cause an increased excretion (especially of alkalis) through the intestinal wall, the result is very likely to be an increase of putrefactive processes which may dominate the fermentation. This, of course, is largely problematic, but it offers a theory which readily explains those cases in which are found putrefactive stools, although the gastro-intestinal disturbance is palpably due to an excess of carbohydrates in the food. It is interesting to note here that Bluhdorn[1] found that the stool bacteria did not produce fermentation in a carbohydrate medium until peptone solution was added and that in no case did the addition of organic acids favor the bacterial growth, while in most cases the growth was inhibited.

As to the source of putrefaction—*i.e.*, as to whether this is due to decomposition of the food protein or the mucus—some discussion may be raised, but suffice it to say that clinically, in a strongly protein diet (casein), very little if any putrefaction is recognizable, and on addition of protein to the food there is no increase of putrefactive products in the stool or urine.

There has recently been a renewed interest in the bacteriology of the intestinal canal in nutritional disturbances. Soli,[2] in some recent observations on rabbits, determined what he thinks is a definite bactericidal power in the intestinal mucosa which is very much reduced with disturbances of the blood supply.

Langer[3] has noted a distinct difference in the growth

[1] Monatsschr. f. Kinderheilk., 1916, viii, 297.

[2] La Pediatria, 1921, xxix, 97.

[3] Zeitschr. f. Kinderheilk., 1920, xxvi, 163.

possibilities of the strains of colon bacilli obtained in the intestinal flora of infants fed on breast milk and from those fed artificially. In the latter the colon bacilli appeared much more active and resistant. Scheer[1] feels that the bacterial flora of the stomach and duodenum depends to a great degree upon the acidity of the stomach. In the lower degrees of acidity he found usually the bacterial flora in the stomach recognized only on culture. In normal conditions in the stomach and duodenum, either no bacteria were found or only an occasional coccus, while in severe dysentery and intoxication there is a definite flora in both. This flora consists mostly of colon bacilli but other organisms such as B. fecalis and B. alkaligines were to be found. In one case gram-negative diplococci were found in pure culture. This was true in dysentery but in intoxication in five cases as a result of the high acid content of the stomach, no bacteria were found. In the duodenum, however, there was a luxurious bacterial flora consisting mostly of colon bacilli. In parenteral disturbances, where dyspepsia existed, the findings were not uniform.

Bessau and Bossert[2] found that invasions of the upper portion of the intestinal canal (stomach and colon) by B. coli and B. lactici acidi are regularly to be found in nutritional disturbances.

[1] Jahrb. f. Kinderheilk., 1920, xcii, 328.

[2] Jahrb. f. Kinderheilk., 1919, lxxxix, 213, 269.

CHAPTER VI

ATTRIBUTES OF THE NORMAL CHILD

To be able to judge the ill effects of certain foods upon the infant organism it is first necessary to be able to judge accurately of any variations from the normal. This necessitates a comprehensive and detailed knowledge of what constitutes the normal. If for no other reason than as a prophylactic measure, the first symptoms of disturbance should be recognized. The tendency to disregard slight gastro-intestinal symptoms is so widespread that one feels helpless in endeavoring to caution even the profession in this regard, but the recognition and proper treatment of slight gastro-intestinal disturbance is of much more importance than the ability to treat more severe conditions when they arise.

Of all things in connection with the infant, none is more useful and none so abused as the *weight* if taken at a given time or in the form of a weight-curve. As one sign of progress in the infant, gain in weight is invaluable, as the only sign, it is to be avoided. To regard a gain in weight as the only sign of progress is to-day the most vital error that is made. The attempt to produce it by giving more food to the infant causes more fatalities than do bacteria and hot weather combined.

At birth the average normal infant weighs from 7 to 8 pounds: the girl baby about 7 to 7½ pounds; the boy, 7½ to 8 pounds. However, a child may weigh as little as

5 pounds or as much as 12 at birth and still be perfectly normal. The initial loss in weight occurs in the first few days, usually the low mark being recorded on the third to the fifth day, after which time the babies begin to gain, and normally reach the original weight on the tenth to the fourteenth day. The usual total loss amounts to from 6 to 8 ounces, but varies in wide boundaries, being as little as 2 to 3 ounces and as high as 1 pound. More than 1 pound loss, especially in a small infant, should be regarded as of pathologic character, and conditions should be carefully investigated in order to determine the cause. Other things being equal, a fat baby is more likely to lose a large amount of weight than a thin one, and large losses in thin babies are, consequently, more likely to indicate pathologic conditions. As to the cause of the initial loss in weight, many theories are advanced. We must, of course, recognize that the loss of meconium and the fact that the child received insufficient food for the first few days of life may account for this condition, but to determine what body constituents go to make up the loss careful experimentation is necessary.

Hirsch[1] thinks that the total loss can be accounted for by the weight of the meconium and Ramsay and Alley[2] by weight of the meconium plus the urine and vernix caseosa. Even if this be true, we must yet account for some body waste which perhaps the meconium contains. Langstein and Niemann found a distinct nitrogen deficiency, but this was not so great as to suggest that destruction of the body proteins and their excretion should account for the total loss in weight. A much more plausible conclusion is that

[1] Ref. Monatsschr. f. Kinderheilk., 1910, ix (Ref.) 2.

[2] Am. Jour. Dis. Child., 1918, xv, 408.

reached by Rott,[1] who, after estimation of the water-content of the blood in the newborn, comes to the conclusion that the initial loss is the loss of water (together with salts), and is due, probably in large part, to the fact that these babies receive little fluid in any form. Birk[2] agrees in the main with Rott. Mensi[3] finds no relation between icterus neonatorum and the physiologic weight decrease. Schick[4] has been able to prevent the initial loss in weight by feeding the child from birth on. He uses a food containing a large proportion of sugar.

After the initial loss and return to the original weight, the normal breast-fed infant will increase more rapidly in the first half than in the second half of the first year. The gain in the first six months should be 6 to 8 ounces a week, while from the sixth to the twelfth month the gain should not be more than 2 to 3 ounces, so that at the end of the first year the weight is about 1 pound a month or 12 pounds' gain since birth. I realize that this may seem very conservative to many, but it has been the experience of the writer that, almost without exception, the baby who is extremely fat at the end of the first year suffers from attacks of gastro-intestinal disturbance during the second to pay for the overtaxing of the digestive functions in the previous months of life.

The question of the normal weight from birth on in the artificially fed infant is an open one. To feed a child from birth on and have it gain steadily and be free from gastro-

[1] Zeitschr. f. Kinderheilk., 1910, i, 43.

[2] Monatsschr. f. Kinderheilk., 1910, ix (Orig.), 505.

[3] La Pediatria, 1912, x, 641.

[4] Zeitschr. f. Kinderheilk., 1916, xiii, 257.

intestinal disturbance is much more uncommon than we ordinarily suppose. To judge of the normality of a child artificially or breast fed, observation of a few weeks is not

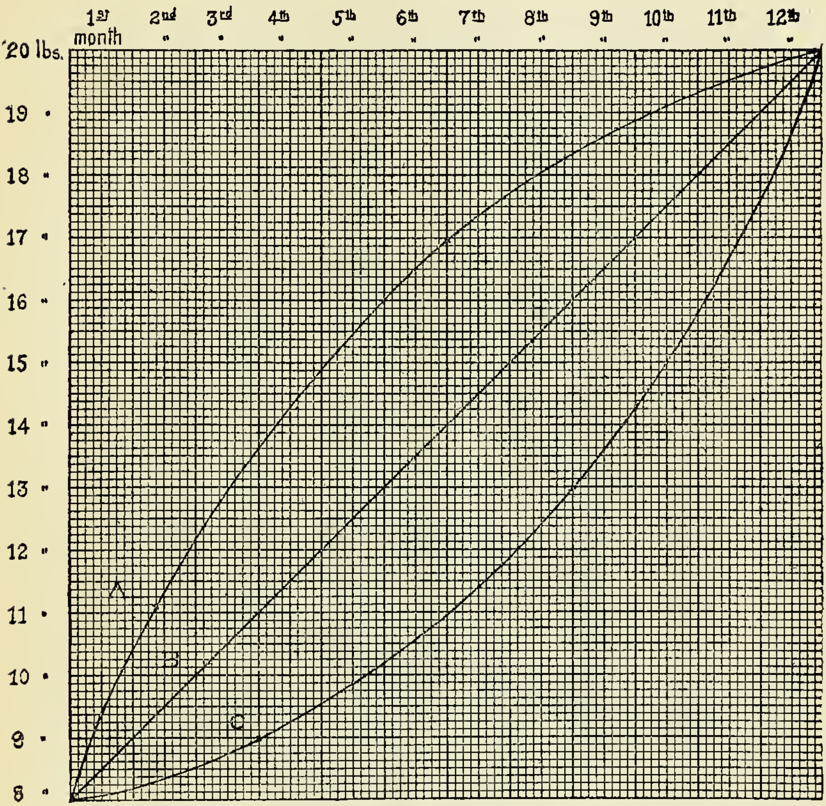


Fig. 3.—*A*, The ideal weight-curve of a normal breast-fed infant (schematic); *B*, the ideal weight-curve of an artificially fed infant (schematic); *C*, the more usual weight-curve of the infant fed artificially and showing no gastro-intestinal symptoms (schematic).

sufficient. There is a steadily increasing tendency on the part of physicians to confine their efforts in artificial feeding in the first weeks of life to the maintenance of a normal

gastro-intestinal tract and pay little attention to the weight. Certain it is that any marked gain in the first few weeks of life in the child fed artificially is usually followed by severe disturbance and resulting marasmus. If we are to regard the weight-curve of the breast-fed infant as the ideal standard by which to judge the artificially fed, we may be sure that we will have few normal artificially fed infants.

Perhaps if we modify this by saying that at the end of the first year the weights should be the same, we may find more infants to the measure. The steady gain of 4 ounces a week during the whole of the first year is the best which we can hope to procure in the artificially fed infant, and this only when all other conditions are normal. A gain of 8 ounces in a week should always make us apprehensive, because almost invariably such an excessive gain in weight is followed by a catastrophe. (This does not hold true for infants convalescent from severe dehydrating intestinal disturbances.) The gain in weight during the second year is very small. Weekly weighings will sometimes show a difference of 1 to 2 ounces. It is not at all unusual, however, to have a perfectly normal infant go for several weeks during the second year without gain in weight.

The *length* of the newborn baby averages about 20 inches (50 cm.), and at the end of the first year, 29 to 30 inches (72–75 cm.). At the beginning of the fifth year the birth length should be about doubled. Variations in length growth are not great, no matter what the state of nutrition of the child. There seems to be comparatively little hindrance to length growth even in severe marantic conditions.

It is very important to recognize the fact that there is

a distinctly normal *temperature* variation for the infant, and that any excursions above or below this mean are abnormal, and are frequently associated with nourishment disturbances. The rectal temperature in the infant corresponds to the oral temperature in the adult, *i. e.*, a temperature of 98.6°F. is considered the normal mean in both instances. The temperature by rectum is the only sure one to employ in infants, and hence no reference will be made to other methods of temperature registration in this work.

The variation in the normal infant should be no greater than from 98.2° to 99°F. It might be mentioned here that subnormal temperature is frequently of great significance. In rare cases premature or marantic infants may react to infections with markedly subnormal temperature.

The *pulse-rate* is to the *respiration-rate* as 4 to 1. The pulse in the newborn is about 120 per minute, and remains well above 100 during the first year of life. The impulse is variable, both as to rate and volume, due to the irritability of the heart at this age. A slowing is as much a variation from the normal as an acceleration. Both pulse and respiration rate should be taken only when the infant is quiet.

The *respiration-rate* in the infant is 25 to 30 per minute. The type of respiration is almost wholly diaphragmatic, due to the fact that the ribs form almost a right angle with the vertebral column, holding the sternum high up and giving the chest a greater anteroposterior diameter. As a consequence of the type of breathing and the slight ability on the part of the body to aid respiration by the use of the accessory respiration muscles, marked variations in respiration-rate are to be noted with comparatively slight disturb-

ances. This is particularly true in abdominal conditions where the action of the diaphragm is impeded.

The *skin* at birth is apt to be very red, often showing distinct desquamation for several days. After the first week, provided no icterus neonatorum be present, this intense red gives place to a pale rose-pink. No abrasion or eruptions of any sort are to be found on the healthy infant's skin, and any such should lead us to search for the cause. As we will see later (Exudative Diathesis), even the fine, grayish-yellow scales found on the scalp in the region of the anterior fontanel are to be regarded as pathologic. The cheeks of the young infant are not normally red, but are found so only in the flush of fever, in the early stages of a facial eczema, or after exposure to cold air.

The *subcutaneous tissue* should feel firm; perhaps the vulgar term "solid" will be more readily comprehended. Flabbiness or hardness without elasticity is not to be seen in the perfectly normal infant. In the following pages the state of the subcutaneous tissue will be referred to as the *tissue turgor,* the tendency to flabbiness as *reduced tissue turgor,* and the hard inelastic edematous condition as *increased tissue turgor.*

According to most observers, in the normal infant the inguinal glands are the only *lymphatic glands* which are palpable. These can practically always be felt as small masses the size of a pin's head or somewhat larger.

Whether we may regard enlargement of the axillary and supracondylar glands as normal seems at least very doubtful. Enlargement of the cervical glands is sufficiently often the result of pharyngeal infection as to lead us to suspect this in every case.

Owing to the lack of calcification, the *bones* in infancy are very elastic. The anterior fontanel does not close before the twelfth to sixteenth month, but under normal conditions should not remain open after the eighteenth month. Just after birth and for the first few weeks there is a slight bulging at the costochondral junction; as a rule this disappears during the second month. Soft spots in the skull, especially in the temporal and occipital bones, and softness of the bones along the sutures, is frequently found in newborn infants; these disappear during the second month and are in no way indicative of rickets (Wieland).[1] Kassowitz[2] strongly opposes this interpretation of Wieland's findings.

The teeth begin to appear usually about the sixth month, and average one a month thereafter. Should the first tooth appear as early as the fifth month or as late as the eighth, one could scarcely regard the condition as pathologic. However, if its appearance is delayed until after the first year or even to the eleventh or twelfth month, there is usually some underlying cause, such as rickets or syphilis. The first tooth to appear is usually an upper or a lower incisor. This is most often followed by the other upper or lower incisor and then by teeth in the opposite jaw. The symptoms accompanying the eruption of the teeth are, at the most, pain and increased flow of salivary secretion. One cannot too strongly deny the repeated assertion that "cutting teeth" causes diarrheas, convulsions, etc. One must suspect that the physician who makes this assertion is blindly endeavoring to veil his ignorance.

[1] Jahrb. f. Kinderheilk., 1909, lxx, 539.

[2] Jahrb. f. Kinderheilk., 1912, lxxvii, 369.

Neither in science nor clinical experience is there any reason whatsoever to connect the eruption of the teeth etiologically with these diseased conditions.

The *urine* of the normal infant is light yellow in color, of slightly acid reaction, specific gravity, 1.005. It contains no albumin or sugar, and at most in the sediment are found a few leukocytes and epithelial cells. In the newborn, even under normal conditions, most writers on the subject agree that albumin may be transiently present. The exact cause of this has not yet been determined. Uric-acid crystals are also found rather frequently in the first days after birth, due to uric-acid infarcts of the kidneys. The quantity of urine passed in twenty-four hours varies greatly with the age of the child and the composition of the food. In the newborn infant on the first or second day this amounts to about 50 c.c., and increases rapidly, so that from the tenth to the fortieth day the twenty-four-hour excretion is 200 to 250 c.c. By the end of the first year the daily excretion may be 500 c.c. or more. Children fed artificially excrete larger quantities of urine than do breast fed. It is almost impossible to estimate the frequency of urination in the young infant. As a rule, there is not a greater interval than two hours between urinations while awake, and not longer than four hours during sleep. Colic and nourishment disturbances are very apt to increase the frequency of urination. According to Moll[1] the urine of the normal breast-fed infant does not contain phosphorus in sufficient quantities for it to be detected by our present chemical technic.

In the normal breast-fed baby defecation occurs twice a

[1] Jahrb. f. Kinderheilk., 1909, lxix, 129, 450.

PLATE II

Stool of normal infant fed on breast milk.

day. The *stool* is orange-yellow in color, of a slight pungent odor, soft and mealy, or stringy in appearance. The reaction is acid. The bacterial flora is Gram positive (Bacillus bifidus communis). The stool of the normal artificially fed infant is passed but once a day. If milk be the only constituent of the food, the color is lemon-yellow, while if malt or starch be given, the color may be either light or dark brown. The odor is frequently offensive. Reaction acid. There is much more tendency to the "formed" stool, and the general appearance is more homogeneous than is the breast stool, perhaps "salve-like" will best describe it. Bacterial flora is Gram negative.

During the first few days of life the *muscular action* of the child is consumed in nursing and in irregular movements of the extremities, which show lack of intention and direction. The cry is never accompanied by lacrimation, which rarely appears before the third month, and usually not until after the sixth. According to Czerny and Keller the normal infant at the end of the third month, when placed upon its stomach, will arch the neck and look around; at the end of the sixth month, will be able to sit up unaided; at the end of the ninth month, will be able to stand, and at one year, will begin to walk. In the experience of the writer it has usually been from one to three months later before the child was able to stand or walk. Usually about a month before walking is attempted some other means of locomotion (as crawling) is resorted to. The activities of the child are of great importance in estimating the clinical condition and should always be observed. Most physicians of large experience do this unconsciously.

The state of the *nervous system* is best shown by two

symptoms, the sleep and the cry. A normal newborn baby sleeps practically all the time, perhaps waking only a few minutes before each nursing period. During infancy there should be at least one long interval of uninterrupted sleep of perhaps eight hours' duration in the older, and six hours in the younger, infants. Where only six hours is taken at one time, the infant should have at least three other periods of three to four hours each. At the end of the first year a child should have a night period of eleven to twelve hours and two day periods of two to three hours each. Throughout infancy the sleep should be very deep, so that even the slamming of a door in the same room will not awaken the baby. Often the depth of the sleep is of great clinical value. Any disturbance of the natural sleep may be regarded as pathologic. The normal infant cries whenever it is uncomfortable. This may mean that it is hungry, or it may mean that its clothing is irritating it, or perhaps it may wish to be held. The cry may be very harassing, but on removal of the cause it ceases. All infants cry at times, and perhaps this crying aids expansion of the lungs.

Another characteristic of the normal infant is its relative *immunity* to infections of all kinds. Czerny lays much stress on this point. It is undoubtedly true that disturbances of nutrition distinctly lower the resistance of the infant, and in all probability the reverse is true (*i. e.*, proper food increases the resistance). A good instance of slight apparent abnormality of the child predisposing to infection is seen in exudative diathesis. It should be stated here that Kleinschmidt[1] was unable to show any

[1] Monatsschr. f. Kinderheilk., 1913, xii (Orig.), 423.

connection between antibody formation and the kind of nourishment.

Finkelstein has added still another characteristic of the normal infant which, perhaps of all, is the least easily estimated and the most important; that is, its wide tolerance for food. In the perfectly normal infant the amount and composition of food may vary within wide boundaries without producing nutritional disturbance. This fact accounts for the wide difference in the results obtained in feeding by any one method or with any single kind of food. The writer has occasionally seen babies who for the first few months of life, if the statement of the mother may be accepted as true, had had nothing to eat but a thick oatmeal gruel, and which, on examination, showed no trace of abnormality and no nutritional disturbance except perhaps a slight degree of rickets. All of us have seen young infants apparently perfectly healthy whose sole diet has consisted of condensed milk, and yet we know that perhaps the most severe cases of nutritional derangement which are encountered are in young infants whose food has consisted wholly of condensed milk. These facts can only be accounted for if we recognize that under normal conditions the infant manufactures its body material out of widely different foods, and is able to do this without causing any derangement of its system.

PART II

NOURISHMENT OF THE INFANT ON THE BREAST

CHAPTER VII

THE HUMAN BREAST AND BREAST-MILK

ANATOMY AND PHYSIOLOGY OF THE HUMAN BREAST

The human mammary gland is a compound racemose gland consisting of several lobes and lobules, each of which is drained by a duct. Several of these ducts join just before reaching the nipple, and just beyond this point a spindle-shaped enlargement occurs, beyond which the duct continues in its usual size to open in the nipple. Each nipple contains fifteen to twenty such ducts.

On microscopic examination the acini are found to be lined with cylindric epithelium, which rests on a rather dense membrana propria, consisting of spindle cells. The adventitial layer which lies beneath the membrana propria consists of a loose network of connective tissue in which are to be seen leukocytes, plasma-cells, and blood- and lymph-vessels. Around the separate divisions of the gland is a dense cell-poor interstitial tissue, while between the lobules and individual acini fat-cells are found. During the period of lactation there is frequently an increase in the number of acini and the blood-vessel supply is richer. Often there is seen to be a denudation of the membrana

propria for some distance in the acini, and just before the formation of milk the epithelial cells appear large and swollen; soon after, ruptured or squeezed out (Foster).[1]

The blood-supply of the mammary gland is derived from the thoracic branch of the axillary and in part from the intercostals. Surrounding the gland is a plexus of veins. The nerve-supply is derived from the second and third dorsal nerves.

COLOSTRUM

The first secretion appearing in the breast after the birth of a child is known as colostrum. It is a thick lemon-yellow fluid which coagulates on boiling. Chemically the colostrum consists of 7.5 to 10 per cent. protein, 2 to 2.5 per cent. fat, 2.5 to 3.5 per cent. sugar, and .3 to .4 per cent. salts. The proportion of lactalbumin and casein is about the same as that of the milk proper, so that the increase in protein is due to the increase in globulin, which, in turn, accounts for its coagulation with heat. Birk[2] calls attention to the ash-content. He finds that in 100 grams of colostrum the total ash is .2814. The various constituents are as follows·

Calcium	.0360 grams.
Magnesium	.0093 grams.
Potassium	.0770 grams.
Sodium	.0544 grams.
Phosphorus	.1137 grams.

The phosphorus content is, therefore, more than double that of the later milk. Langstein, Rott, and Edelstein,[3] examin-

[1] Text-book of Physiology, 1896, p. 610.

[2] Monatsschr. f. Kinderheilk., 1910, ix (Orig.), 595.

[3] Zeitschr. f. Kinderheilk., 1913, vii, 210.

ing the caloric value of colostrum, found that it varied between 500 and 1500 per liter, and that the highest values corresponded to a thick, yellow, tenacious fluid. Microscopically, besides the fat-globules and occasional epithelial cell and some leukocytes, we find the characteristic colostrum corpuscles. These are cells, some small, many large, which contain single or many fat-globules. These globules are surrounded by the cell protoplasm, and occasionally a distinct cell nucleus can be seen crowded to the edge of the cell. The source of these corpuscles is a subject of some dispute. It had formerly been supposed that they were epithelial cells in which were included fat-globules, but Czerny is of the opinion that they are leukocytes, because of the fact that leukocytes are found in the colostrum in appreciable quantities, although they do not appear in the milk itself Resch[1] agrees with Czerny's ideas. Plantenga and Filippo[2] do not agree with these contentions because in colostrum they have not been able to find any leucocytes laden with fat but only epithelial cells. Thomas[3] states that both the polynuclear and mononuclear colostrum corpuscles possess a distinct phagoctyic action.

Colostrum is present throughout the latter months of pregnancy, but an attempt to express it from the breast produces severe pain. Usually the flow of colostrum begins on the second day after delivery, the corpuscles appearing on the fourth or fifth day. The corpuscles usually disappear in the first few days, but may continue for many

[1] Jahrb. f. Kinderheilk., 1917, lxxxv, 377.

[2] Zeitschr. f. Kinderheilk., 1916, xiv, 166.

[3] Zeitschr. f. Kinderheilk., 1913, viii, 291.

weeks. It is interesting to note that when the breast-milk is giving out these corpuscles reappear, and the fluid begins to take on more the character of colostrum. Colostrum is slightly laxative in its action. According to Birk,[1] colostrum is a necessary food for the newborn infant and cannot be replaced by ordinary breast-milk without danger.

BREAST-MILK

The change from colostrum to the permanent secretion of the mammary gland is more or less gradual, consuming perhaps a week. The milk proper has a somewhat bluish tint, and appears thinner, as a rule, than cows' milk. Specific gravity is about 1.028 to 1.035, varying with the concentration and the fat-content. The reaction is slightly alkaline or, according to Davidsohn,[2] neutral. Under normal conditions, microscopically, little is to be seen but fat-globules, perhaps an occasional epithelial cell. Under pathologic conditions, bacteria of various sorts, pus-cells, and even blood are frequent constituents. The writer has seen one case where the fat layer after centrifugalization was a deep orange color. In this case it was necessary to take the infant from the breast temporarily because of a severe gastro-intestinal disturbance. Some weeks after, however, the child resumed the breast-milk with very gratifying results. Neither microscopically nor by culture was any adequate explanation of this fat coloration given.

Chemical Composition of Milk.—Chemically the human breast-milk consists of proteins, fats, sugar, salts, and

[1] Monatsschr. f. Kinderheilk., 1910, ix (Orig.), 595.

[2] Zeitschr. f. Kinderheilk., 1913, ix, 11.

ferments.[1] Even under perfectly normal circumstances and in the same woman at different times the composition of the milk may vary within wide boundaries. There is no general tendency, so far as has been determined, for any one constituent of the breast-milk either to increase or decrease as the period of lactation advances. It is very likely that all chemical variations in the breast-milk not due to local or general diseases are well within the limits of the normal, and that disturbances in children nourished at the breast are due to a defect in the child's organism or to inability on the part of the infant to thrive on the quantity of milk which it obtains (too much or too little). A possible exception to this may be rickets in breast-fed children, where, according to Ramacci,[2] there is a reduced calcium-content in the milk.

The *protein-content* of human breast-milk varies between 1 and 2 per cent. Lactalbumin and casein form the chief constituents, though lactoglobulin is found in small quantities. The proportion of lactalbumin to casein is about 1 to 2 or 3 to 4. Lempp and Langstein[3] could determine no difference in digestibility of the casein and the lactalbumin of breast-milk, nor could Bergell and Langstein[4] determine any constant chemical variations between the casein of women's milk and that of the milk of lower animals, except that the potassium is higher (Langstein).[5] In

[1] A detailed tabulation of the various results of examinations of the chemical composition of breast-milk will be found in Czerny and Keller, Bd. i, 414–431.

[2] La Pediatria, 1910, xviii, 665.

[3] Jahrb. f. Kinderheilk., 1910, lxx, 363.

[4] Jahrb. f. Kinderheilk., 1908, lxviii, 568.

[5] Jahrb f. Kinderheilk., 1910, lxxii, Ergansungsheft, 1.

this connection it is interesting to note that Finizio[1] finds that about 15 to 25 per cent. of the total nitrogen in human breast-milk is derived from non-protein material, such as urea, creatinin, etc.

The *fat* of the breast-milk is in much finer emulsion than that of cows' milk, and varies between 3 and 4.5 per cent. It consists principally of palmitin, stearin, and olein, with traces of the lower fatty acids, such as butyric. From a general standpoint most interesting are the findings of Engel.[2] In examining the fat-content of the milk he determined that at the beginning of the nursing period the proportion of fat was low, and that as the period advanced the fat increased very greatly. In most cases the increase in fat was steady from the beginning to the end of nursing, but in some the steady upward trend of the fat-curve was broken in the middle by a slight depression. We see, therefore, that the last milk from the human breast is high in fat, an analogous condition to that found in the cow. Sisson and Denis[3] found that the cholesterin content of the breast milk averages about 50 mgms. per 100 c.c., but that there is a wide variation from 20 to 110 mgms. They did not feel that the diet is an essential cause of this variation.

The only *carbohydrate* found in breast-milk is *milk-sugar*. This is present in about 6 to 7 per cent. It varies less perhaps than does any other of the organic constituents. Denis and Talbot[4] found that the lactose content of breast-milk shows a rapid increase during the first few days of life

[1] La Pediatria, 1908, xvi, 401.

[2] Archiv. f. Kinderheilk., 1906, xliii, 181.

[3] Jour. Am. Med. Assoc., 1920, lxxv, 601.

[4] Am. Jour. Dis. Child., 1919, xviii, 93.

and a further increase as lactation progresses. The lactose is usually higher at the beginning of the nursing period than at the end.

Cornelia de Lange,[1] by examination of a mixed women's milk from 33 women in the fourth to tenth day after delivery, found in 100 grams of ash the following:

K_2O	19.9 per cent.
Na_2O	29.6 per cent.
CaO	12.9 per cent.
$Mg.O$	2.9 per cent.
Fe_2O_3	0.25 per cent.
P_2O_5	17.9 per cent.
Cl_2	21.3 per cent.

The figures of Schloss[2] vary somewhat from those just quoted. He finds that the calcium in early milk forms about 11 per cent. of the total ash, while later it rises to about 20 per cent. The others he gives as follows:

Sodium	10 per cent.
Potassium	30 per cent.
Chlorin	16 to 17 per cent.
Phosphorus	about 20 per cent.

According to Orgler[3] the calcium decreases with the advance of the lactation period.

In mothers' milk the *iron* is very small in amount. To supply the body needs during the first months in all probability iron is stored up during fetal life, since it is not present in sufficient quantity in the food to supply the demand.

[1] Czerny-Keller, Bd. i, 427.

[2] Monatsschr. f. Kinderheilk., 1912, x (Orig.), 499.

[3] Ergeb. d. inn. Med. u. Kinderheilk., 1912, viii, 142.

In examining the calcium-content of mothers' milk, Ramacci[1] found that normally it varied between .09 to .12 per cent., and that neither the age of the mother nor the month of lactation influenced it. He found, however, that the mothers of rachitic or spasmophilic infants produced a milk which was low in calcium. Bahrdt and Edelstein[2] came to much the same result, except that they found the calcium-oxid-content to be only .03 to .04 per cent. Plantenga and Filippo[3] found that in no case were there more than 50 mgms. of chlorine per 100 gms. of breast milk. The content in chlorine was not materially changed by menstruation.

Various investigators have found enzymes in the milk, among which may be mentioned a proteolytic ferment, galactase, lipase (Davidsohn[4]), and a ferment which splits salol into phenol and salicylic acid (Usener[5]).

So far as we know, these are of constant occurrence. As to whether they are vital to the proper action of the milk has not been determined, but it is probable that their presence is more or less an accident than a distinct characteristic.

[1] La Pediatria, 1910, xviii, 665.

[2] Jahrb. f. Kinderheilk., 1910, lxxii, Erganzungsheft, 16.

[3] Zeitschr. f. Kinderheilk., 1916, xiv, 166.

[4] Zeitschr. f. Kinderheilk., 1913, viii, 14.

[5] Zeitschr. f. Kinderheilk., 1912, v, 431.

THE COMPOSITION OF BREAST MILK

Bosworth's Tables[1]

Constituents	Original milk 100 c.c., gm.	Milk Serum 100 c.c., gm.	Milk Constituents in serum percentage
Fat	3.30	0.00	0.00
Casein	....	0.00	0.00
Albumin	*1.20	0.131	*(13.10)
N in other compounds calculated as protein	0.307	0.307	100.00
Citric acid	0.1055	0.1055	100.00
P, organic	0.0008	0.00	0.00
P, inorganic	0.0148	0.0148	100.00
Ca	0.0354	0.0214	60.45
Mg	0.0030	0.0030	100.00
Na	0.0147	0.0147	100.00
K	0.0711	0.0711	100.00
Cl	0.0375	0.0373	100.00

* Determination of casein in whole milk very unsatisfactory, therefore not given. It was about 0.2 gm. per 100 c.c. milk.

Fat	3.30
Milk sugar	6.50
Proteins combined with Ca	1.50
Calcium chloride	0.059
Mono-potassium posphate (KH_2PO_4)	0.069
Sodium citrate ($Na_3C_6H_5O_7$)	0.055
Potassium citrate ($K_3C_6H_5O_7$)	0.103
Mono-magnesium phosphate ($MgH_4P_2O_8$)	0.027

Tables of Holt, Courtney & Fales[2]

Percentage Composition of Woman's Milk by Periods

Period	No. of analyses	Fat	Sugar	Protein	Casein	Albumin	Ash	Total solids
Colostrum (1–12 days)	5	2.83	7.59	2.25	....	....	0.3077	13.42
Transition (12–30 days)	6	4.37	7.74	1.56	....	....	0.2407	13.39
Mature (1–9 mos.)	17	3.26	7.50	1.15	0.43	0.72	0.2062	12.16
Late (10–20 mos.)	10	3.16	7.47	1.07	0.32	0.75	0.1978	12.18

[1] Jour. Biol. Chem., 1915, xx, 707.

[2] Am. Jour. Dis. of Children, 1915, x, 229.

Averages for the Different Periods

	No. of analyses	Total ash	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
Colostrum (1–12 days).	5	0.3077	0.0446	0.0101	0.0410	0.0453	0.0938	0.0568
Transition (12–30 days)	6	0.2407	0.0409	0.0057	0.0404	0.0255	0.0709	0.0580
Early mature (1–4 mos.)	9	0.2056	0.0486	0.0082	0.0342	0.0154	0.0539	0.0351
Middle mature (4–9 mos.)...............	8	0.2069	0.0458	0.0074	0.0345	0.0132	0.0609	0.0358
Late milk (10–20 mos.)	10	0.1978	0.0390	0.0070	0.0304	0.0195	0.0575	0.0442

Average Percentage Composition of Ash for the Different Periods

	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl
Colostrum.............	14.2	3.5	12.5	13.7	28.1	20.6
Transition.............	17.0	2.4	16.0	10.9	30.8	22.9
Mature................	23.3	3.7	16.6	7.2	28.3	16.5
Late..................	19.8	3.6	15.5	10.1	28.8	22.3

Excretion of Drugs in Breast-milk.—Much has been said about the passage of *drugs* through the milk, but little positive evidence of such is at hand. Reed[1] carefully collected the literature on this subject. In general, one may say that in physiologic doses very few drugs pass over into the breast-milk, while in poisonous doses most of them do. *Alcohol* has probably received the most attention. It has been found that in doses of 100 c.c. no alcohol was detected in the milk, while when 200 c.c. were given, 35 c.c. were recovered in the milk. Frontalli[2] could never detect more than 2 c.c. of alcohol in the twenty-four-hour milk supply. Alcohol, therefore, agrees with the general rule. No chemical proof exists of *opium* or its derivatives in the breast-milk after the same is taken by the mother. *Atropin* or *belladonna* in physiologic doses do not appear in the

[1] Surg., Gyn., and Obst., 1908, vi, 514.

[2] Riv. di Clin. Ped., 1915, xiii, 693.

milk. There is some uncertainty about *chloral hydrate, chloroform*, and *ether*, but enough indefinite evidence is at hand to make us cautious in their use. *Quinin* and *salicylic acid* probably do not pass over. *Potassium* and *sodium bromid* do appear in the milk, as is shown chemically, as do also *antipyrin* and *phenacetin*. Van Der Bogert[1] has recently reported a case of bromine poisoning in a breast-fed infant whose mother was taking large quantities of a patent medicine which contained a considerable amount of bromides. *Mercury* has never been found in the breast-milk, in spite of the often repeated assertion of the favorable action of antisyphilitic treatment of the mother on the nursing child. On the other hand, *iodin* and its derivatives are readily recognized. *Arsenic* has been found in the milk after the use of Fowler's solution and salvarsan (Caffarena).[2] There is doubt as to *iron* appearing in the milk because of the presence of that metal in small quantities normally. *Bismuth* and *copper* occur in insignificant quantities. It is likely that *thyroid extract* does occur in the milk after its administration to the mother, at least the clinical reports would seem to favor this view. Much difference of opinion exists as to cathartics, but it is probable that most of them are conveyed through the milk to the infant in quantities sufficiently large to cause a slight laxative action, at times perhaps more.

As regards bacteria, the *Staphylococcus albus* can be grown from practically every specimen of breast-milk, even if all antiseptic precautions are used in pumping or otherwise emptying the breast, so that its presence cannot

[1] Am. Jour. Dis. Child., 1921, xxi, 167.

[2] La Pediatria, 1912, xx, 295.

be regarded as pathologic. The source of this organism is probably the skin. *Staphylococci in large numbers,* especially if *pus* be present, can, however, be regarded as pointing strongly to either a local or general infection. It has been shown clinically that the organism causing pneumonia (the pneumococcus) and those of the other acute infectious diseases can pass into the milk. This is also true of tuberculosis, and Heiman[1] recently reported an infection with typhoid in an eight months' old infant from the breast-milk of the mother. Wang and Coonley[2] have been unable to demonstrate the tubercle bacillus in the milk of tuberculous women. It is interesting to note that the milk of lactating women suffering with typhoid fever often gives the Widal reaction. Rojas[3] found the Wassermann reaction to be positive in the breast milk in a large proportion of recently delivered syphilitic women, and his findings have been corroborated by Rusca.[4] At times diphtheria toxin and antitoxin have been found in the breast-milk. Kleinschmidt[5] has demonstrated the presence of bactericidal amboceptors in breast-milk, which he regards of much importance since the infant's blood contains a sufficient complement. Jundell[6] has found that the opsonic index is about the same in human and cow's milk, it being between 2 and 3. Boiling the milk seems to make no difference.

[1] Jour. Am. Med. Assoc., 1919, lxxiii, 913.
[2] Jour. Am. Med. Assoc., 1917, lxix, 531.
[3] Semana Medica, 1919, xxvi, 100.
[4] La Pediatria, 1921, xxix, 121.
[5] Monatsschr. f. Kinderheilk., 1911, x, 254.
[6] Nord. Med. Ark., 1912, Afd. II (Lit.), 44.

FACTORS INFLUENCING THE MILK

Why within a few hours or days after birth of a child the breast-milk should begin to flow has been the subject of much controversy. The work of Basch[1] throws some light upon this matter. By injecting a placental extract subcutaneously into a bitch which had previously littered, but which at the time was producing no milk, he was able to cause a distinct action of the mammary gland, and this even after the gland had been removed from all nerve connections and been transplanted beneath the skin of the back. He was unable to produce the same results in a bitch which had not previously littered until after the transplantation of the ovary of a bitch which contained corpora lutea. He was able to produce milk secretion in the glands of 3 four months' old infants by repeated injections of placental extract. This work would certainly suggest a distinct connection between the placental products and the beginning of milk secretion.

In regarding the factors which influence the breast-milk, one must always bear in mind that it is a true secretion, and in an insignificant measure only, an excretion.

Since this is true, the food ingested by the mother can only indirectly influence the amount and composition of this milk. Therefore, we can expect no regular result from the same alterations of diet in any series of cases. The increase in the fat of the mother's food will by no means regularly increase the fat of the milk; the same holds true of the proteins. In fact, we must come to the rational conclusion that changes of diet in the mother are of value only in so much as they affect her general bodily health, and,

[1] Monatsschr. f. Kinderheilk., 1909, viii, 513.

again, and of no less importance, in so much as they influence her psychic condition. Too much stress, however, cannot be laid on the relation of the psychic condition of the mother to the flow of the breast-milk. It is frequently necessary to make an anxious mother feel that she is dieting for the sake of the infant, and the psychic result of such sacrifice is frequently of great value. In no other way can we explain the most contradictory results of dietetic treatment in cases of reduced breast-milk which are reported in the literature and which we all have met in practice.

Hoobler[1] found that the most efficient diet for a nursing mother contained 2400 to 2900 calories of food. This produced better results than diets containing 3400 to 3700 calories or those containing less than 2000 calories. Animal proteins seem to him to be better than vegetable proteins, and cow's milk protein to be the best form. The protein derived from nuts and food with other vegetable proteins is acceptable. The protein should be in the ratio of one calorie of protein to six of fats and carbohydrates. This ratio refers to the proportion of digestible protein to that of digestible fats and carbohydrates. Spolverini[2] found that the best results in nursing were to be obtained after the second or third pregnancy, and in mothers between the ages of 25 and 35.

Healthy women are certainly better able to nurse their children than sick ones. By healthy women the writer does not refer to those having a large amount of adipose tissue nor to those addicted to excessive exercise, but

[1] Jour. Am. Med. Assoc., 1917, lxix, 421.
[2] Riv. di Clin. Ped., 1916, xiv, 505.

to the women who exercise the functions of woman's existence normally. If we can accept this as a premise, it certainly follows that our efforts in the case of every nursing mother should be directed toward keeping up her general health to the optimum.

To a certain extent, but only to a certain extent, is regulation of the diet of any avail. We should avoid in the diet such foods as are not conducive to the general health of the individual. We should endeavor to regulate the bowels of the mother by attention to diet rather than by resort to drugs. We should study the psychic side of the mother, and gauge our advice as to diet to a great extent by her attitude. To preserve general health a certain amount of exercise is always of value. Too much exercise is as little to be desired as too little. The amount of exercise should depend to a large extent upon what the patient herself has been accustomed to.

It is certainly true that in some cases the nursing babies of *menstruating women* do not do well. Frequently at the time of the menstruation the child is cross and sleep is disturbed, and the stool, which has previously been normal, becomes somewhat more frequent, of green color, and curdy. This condition is, however, in nearly all cases temporary and ceases with the end of the menstruating period. Under such conditions it is not advisable to remove the child from the breast even temporarily. Menstruation of the mother in itself is not sufficient cause for removal of the child from the breast. It is interesting to note that Bamberg,[1] however, has been able to find no difference either in quantity or chemical composition during the menstrual period. Grulee

[1] Zeitschr. f. Kinderheilk., 1913, vi, 424.

and Caldwell[1] were able to show in one case that the quantity of milk secretion was lowest four to seven days before the appearance of the menstrual flow and reached its highest during the period.

Among the laity there is a widespread idea that *pregnancy* in a nursing woman is an absolute indication for weaning the baby. Poirier (quoted by Budin)[2] found that 72 per cent. of lactating pregnant women could nurse their babies. We so frequently see women who have passed through the early months of pregnancy giving nourishment to their babies, and the latter thriving, that we can hardly regard pregnancy itself as a direct indication for weaning. Usually, if any disturbance of nutrition develops in the child, it is only after the mother learns her condition. This frequently acts as a distinct nervous shock, and here again we have the psychic element to deal with. Among certain classes of women, where the pregnant state is almost continuous after marriage, it is not unusual to see a six, seven, or even eight months' pregnant woman nursing a healthy child.

INDICATIONS FOR REMOVAL OF CHILD FROM BREAST

The importance of this subject cannot be overestimated. One of the most responsible positions in which a physician can be placed is that of determining if there is sufficient cause for removal of the child from the breast. Even with the utmost care and honesty the future may show us to be wrong in our decision, a fact which may mean the death of the infant. One cannot emphasize too strongly the

[1] Am. Jour. Dis. Child., 1915, ix, 374.

[2] The Nursling, London, p. 96.

importance of giving the infant milk from its mother's breast whenever it is possible to do so. All indications, with one or two exceptions, are relative, but attention should be called to conditions which may arise.

If by weighing a child before and after each nursing it is found that it is *obtaining little or nothing from the breast*, and if this is due to insufficient supply and not to dyspepsia, the infant should either be taken from the breast or mixed feeding should be resorted to, depending, to a large extent, upon the amount of breast-milk obtained by the child.

During the fever stage of the *acute infectious diseases* the child must be removed from the breast. During convalescence it is not often possible for the mother again to nurse the infant, both because of her depleted condition and because of the failure of the milk to appear. *Open tuberculosis* in the mother is an absolute contraindication to breast nursing, both because of the almost absolute certainty of the infection of the child, and, second, because of the bad effect on the mother. Latent tuberculosis especially of the peribronchial lymph-glands is so frequently present in all adults as to be disregarded in this connection.

The path to follow in bone and gland tuberculosis must depend upon the extent and severity of the infection. In very mild cases, where there is involvement of no other organs and where lactation does not influence unfavorably the course of the disease, there is no reason for removal of the child from the breast.

Whether the child, mother, or both have manifest signs of *syphilis*, the baby should be nursed by its own mother. One should remember that in order to make the child

thrive it is just as important in this instance to treat the mother as to treat the baby. Under no circumstances allow a syphilitic baby or the offspring of syphilitic parents, whether that child shows signs of syphilis or not, to suckle a healthy woman. The reason for this is obvious.

Valvular or *muscular diseases of the heart* are not of themselves contraindications to nursing. For instance, a slight, compensating mitral regurgitation will certainly offer no sufficient reason for weaning. In severe acute affections, such as endocarditis and pericarditis, the case should be decided according to the same rules as those given for acute infectious diseases.

Nephritis in most instances, especially in the acute cases, is a contraindication to nursing, but certainly a woman suffering with chronic nephritis of a slight degree will, if careful of her diet, be well able to nurse her baby.

Insanity is a direct contraindication to nursing. It is conceivable that under certain circumstances an *epileptic* might be able to nurse her child, but, for all practical purposes, the presence of epilepsy of the mother is an absolute contraindication to nursing.

Violent fits of anger or *other sudden emotions* may cause temporary cessation or reduction in the flow of milk, and their repeated occurrence should be guarded against.

Women with *cancer* or other malignant growths are, as a rule, unable to nurse their babies, and, even though able, probably the toxic products present in the milk render it unfit.

Other general affections, except under unusual conditions, do not affect the maternal nursing.

In the *breast* itself, *tuberculosis* of one or both breasts

and *cancer* are absolute contraindications to nursing. *Abscess* of one breast rarely necessitates removal of the infant from the other except, perhaps, in the acute febrile period. *Inverted nipples* may cause great difficulty, which can be temporarily overcome by the use of a breast-shield, but it is practically impossible to so evert the nipple that the child can grasp it, and sooner or later the attempt to nourish the infant with the help of the nipple-shield must prove impossible, because of the failure of the child to obtain the requisite amount of food and the failure of the breast to properly develop its lactating powers. *Cracked* and *painful nipples* are the source of great inconvenience, but only in certain instances can they be regarded as indications for weaning. If a cracked nipple does not heal under applications of compound tincture of benzoin, then temporary removal of the child from that breast may aid. Oftentimes the continued application of many layers of dressings soaked with warm, almost saturated solution of magnesium sulphate is of value (Cary[1]). The great danger lies in infection; therefore, careful antisepsis of the child's mouth and the breast surface should be observed. Painful nipples are a source of great pain and annoyance, and the effects on the nervous system of the mother may rarely be so severe as to make removal from the breast advisable.

Hare-lip and *cleft-palate* in the nursing infant may cause difficulty. Hare-lip is not, as a rule, the source of so much trouble in the early months, when the nursing is carried on largely by the hard palate and gums, and later the case may be operated upon, which, if the result should be satisfactory, will enable the child to fit the mouth about the

[1] Personal communication.

base of the nipple in such a way as to enable the inspiratory action of the sucking to aid in emptying the breast.

Cleft-palate is a serious difficulty. It is necessary to nurse the child interruptedly, so that it can get its breath. An early operation is advisable if the state of health of the child will permit it.

Fig. 4.—Proper position for breast nursing, with mother in recumbent position.

CHAPTER VIII

TECHNIC OF BREAST NURSING OF THE NORMAL INFANT

Care of the Breast and Nipples.—Before and after each nursing the nipples and the adjoining portion of the breast should be cleaned with a concentrated solution of boric acid. This accomplishes two purposes: it helps to prevent infection of this region from the mouth of the infant, which is especially likely to occur if a fissure or abrasion of the nipple is present, and it removes any infectious material from the skin of the breast which otherwise might be taken with the food. Between nursings the nipple and adjacent skin should be covered with a clean cloth or, if practical, with a piece of sterile gauze. No corset should be worn which in any way presses upon the breast.

Position of the Child While Nursing.—When the mother is in bed the child should lie to the side from which it will nurse, the breast being held away from the nose, so as to allow free passage of air. With the mother in a sitting posture, the child's head should rest on the raised knee, the foot being supported on a stool, and the child nurse from the pendulous breast of the same side. In this way the breast is easily held from the baby's nose and respiration is free.

Rotation of Breasts.—The child should be nursed alternately, first on one breast and then on the other. It is possible that when the breasts are low, as in the convalescence from some acute illness, it may be better to allow the child to nurse both breasts at the same nursing. This,

however, frequently disturbs the child, and rarely, increases the flow of milk.

The **amount of food** which the normal breast-fed infant obtains, of course, varies with the age and, to a great extent, with the individual. Any table like the following can only claim to give a general idea of what is usually to be expected. The mere fact that any infant gets more or less than any such table may show, in itself does not mean that the child is getting too much or too little food; this must be judged from the infant's general condition. The table is only given as a general guide, and should be regarded as such:

Daily Quantity

Time	Cubic centimeters	Ounces
First week................	250–300	8–10
First month...............	600–650	19–20
Second month..............	815–820	26
Third month...............	800–850	25–27
Fourth month..............	850–900	27–29
Fifth month...............	900–950	29–30
Sixth month...............	1000	32

From this table it will readily be seen that after the first month the increase in the amount of breast-milk which the average child obtains is minimum, amounting in five months, at the most, to 6 ounces.

The amount of the individual feeding varies greatly, according to the child and especially according to the interval between nursings. On the first day it is best to give only sterile water sweetened with *saccharin.* On the second day the child should obtain only 1 ounce or a fraction of an ounce at each feeding. By the end of the first week, if the infant is nursed at four-hour intervals, it should get about 10 to 12 ounces in twenty-four hours, or

Fig. 5.—Proper position for breast nursing, with mother in sitting position.

about 2 ounces to a nursing. The increase from now on is gradual—at the end of the first month being 3 to 3½ ounces at a single period, during the second and third months about 5 ounces, and after this little gain, being about 6 ounces at six months.

There has been much discussion as to the **length of the interval between nursings.** Those who advise a short interval (two hours) think that such stimulates the breast secretion by repeated withdrawal of the milk, and that the infant by nursing so often gets less from the breast, and hence does not distend the stomach. The advocates of the long interval (four hours) assert that by allowing the breast to become full each time between nursings you promote a better action of the breast, and hence a greater supply of milk, and that by giving the food to the infant at long intervals you give its stomach a rest, and that part of the food taken passes almost immediately through the pylorus, consequently the stomach is not distended. This is perhaps the most important question of all those connected with breast feeding, and must be definitely decided. It seems to the writer that the latter position is more rational, and in his hands and that of several of his obstetric colleagues has met with unexpected success. It is certainly true that in two hours the infant's stomach is not empty. To add food to a stomach which already contains partially digested food would seem, and is, injurious. This is doubly so when we stop to think that the last milk from the breast is rich in fat, and that if the breast be emptied at frequent intervals it has not time to fill completely, and hence gives a food rich in fat, that organic food-stuff which remains longest in the stomach. It has

been the custom of the writer for the past few years never to feed any infant oftener than every four hours. New-born infants are put to the breast every four hours during the day and night. If the mother can be persuaded to carry out these orders, there is no better prophylactic for over-feeding and consequent colic. The best hours for nursing are 2, 6, and 10 A. M. and 2, 6, and 10 P. M. In infants over a month old one night nursing is sufficient. This should be given at midnight. If a baby has been fed irregularly at short intervals, or even regularly every two hours, it will require emphasis on the part of the physician to have his orders obeyed, but I am sure that he will never regret the change if the results on the child alone are taken into consideration.

Stress should be laid upon **regularity in nursing.** In the first place, this regularity acts most beneficially on the infant's nervous system and accustoms it to certain times for food, rest, and play. In the second place, it aids digestion. And again, regularity makes the breast-milk more uniform in quantity and quality. One is frequently asked to state the *length of time* that the child should remain *at the breast* for a single nursing period. In my experience this is absolutely an individual question. The ease with which the baby obtains its food varies as much as do the breasts of different women. Again, some children are weak, some strong, some without appetite, some greedy. As an arbitrary limit it is probably not well to leave a baby at the breast longer than fifteen or twenty minutes. In restricting the time at the breast we must always take into consideration that in the first five minutes the child gets as much as in the next ten.

To determine the amount of milk which is obtained from the breast, the baby can be weighed before and after nursing. This can only act as a rough guide, since different babies require different amounts of food in order to thrive properly. If the baby be weighed under the same conditions (naked) at the same hour in the day, and at the same time in relation to the taking of food, if breast fed it may gain 6 ounces a week and be normal, provided no untoward symptoms are present. A greater gain may, in exceptional instances, be followed by no injurious consequences, but not many babies can take care of an amount of food requisite to produce a greater gain in weight without, in a short time, paying for their greediness.

It is well in the first months of life to accustom the baby to take water from a bottle. Later, occasionally a bottle feeding should be substituted for a nursing, in order to accustom the infant to the bottle and thus make weaning less difficult. If started early, this is usually easy.

There is general agreement that after the *ninth month* a baby thrives better if fed artificially. Almost without exception the baby fed a longer time on the breast shows signs of rickets or a more grave nutritional disturbance. One of the materials in which the breast-milk is deficient is iron, and this important constituent must be given in the artificial foods. One must use reason as to the length of the lactation period, since weaning in the hot months or just previous to these is apt to be followed by serious consequences. It is never of advantage to the child to nurse it longer than one year.

The question may arise as to whether one woman can with advantage nurse more than one baby. This is best

answered by citing the cases of wet-nurses in large foundling homes; here we find one woman nursing two, three, and even four babies; in fact, Budin mentions one nurse who nourished five for a short period. Naturally, every woman cannot be expected to do this, but the reaction of the breast to the increased stimulation is often surprising.

It is frequently of advantage to put the infant to the breast again after it has been removed for a shorter or longer period. In most cases we can expect very little success if the child has been away from the breast for a longer time than a week. That it is never too late to try, the following case, I think, will illustrate: Baby S——was born at Provident Hospital, and on the fifth day developed a high fever, with diarrhea and vomiting, although it had been fed exclusively on the breast. On removing the child from the breast and substituting artificial food, the temperature dropped and the gastro-intestinal symptoms disappeared. The child remained at the hospital for six weeks, with no gastro-intestinal symptoms, but practically stationary weight. At the end of this time I was very much surprised to have the father ask me if I thought the baby could go home and nurse its mother. On inquiry I found that the breasts had been kept active during this time by artificial means. The child was taken home, given the breast-milk, and soon became a fat, healthy baby.

Weaning.—Weaning is frequently a very difficult task, and always requires the absolute co-operation of the mother. In younger infants one can usually substitute a bottle for a breast feeding, gradually increasing the number until the child is completely weaned.

In infants over six months of age, however, to attempt

such a procedure is usually without effect. No way is open except sudden removal from the breast and feeding entirely with artificial food. It is often remarkable and rather disturbing the stubbornness with which these children will hold out, but there is no grave danger, and their will must be matched by those of the attendants. As a prophylactic measure it is always well to accustom the child to the bottle early in life.

Wet-nursing.—In the United States wet-nursing represents a very difficult problem for the physicians to solve. The natural independence of the lower classes and their failure to appreciate superiority of any sort, combined with the frequent haughtiness of their employers as a result of newly acquired prosperity, raises almost insuperable barriers to domestic peace when a wet-nurse is introduced into the home. Most of the problems of wet-nursing are, then, those for a diplomatist, in which capacity the physician must exercise his powers. In choosing a wet-nurse we must frequently depend upon her friends' statements as to her moral character. We must, however, take every precaution to see that she is physically healthy. Three diseases must be especially guarded against—tuberculosis, syphilis, and gonorrhea. Physical examination will usually reveal the presence of tuberculosis, but such is not true of syphilis. Where possible, a Wassermann reaction should be obtained. As to gonorrhea, a careful examination of the vaginal secretion should be made.

Perhaps the best proof of the ability of the wet-nurse to supply food is to be found in the health of her infant. This should always be carefully examined and all signs of disease noted.

In instructing the wet-nurse we must always bear in mind that her anxiety for her own offspring is great, and due emphasis must be given it. Aside from the fact that failure to properly care for her child may cause serious consequences because of the effect on the milk of the woman's mental state, the physician is morally bound to see that this infant receives the most careful attention. Perhaps in the majority of instances it is not advisable to allow the child to be nursed to have the total supply of milk of the wet-nurse. As a rule, this would be to favor a catastrophe from overfeeding, or else to allow the breasts of the wet-nurse to retrogress because the weak infant was not strong enough to offer them the proper stimulation. The first few days should never be the criterion of the usefulness of any given wet-nurse. The complete change of surroundings and diet are frequently the cause of disturbances in the flow of milk, and until the woman becomes accustomed to these one should not judge of her fitness as a nurse.

Undoubtedly, the difficulties surrounding this problem have led us to regard it as a means of last resort. From the standpoint of practical medicine it is unfortunate that this is true, but there is no tendency in this country for a change so radical as to cure this evil, and hence it is likely that wet-nursing for some time to come will remain in its present relative relation, and that our most extensive efforts will be directed toward procuring the proper artificial food for the nutritionally disturbed infant.

Sedgwick[1] advises the use of expression of the milk rather than the breast-pump when it is desired to empty the breast. This is carried out by grasping the breast between the thumb

[1] Jour. Am. Med. Assoc., 1917, lxix, 417.

and index finger about 1 to 2 cm. back of the areola and then applying the milking motion toward the nipple. He advises against the use of massage of the whole breast. This may prove of value to institutions where wet nurses are employed. The writer prefers the breast-pump such as the suction pump described by Caldwell.[1]

Mixed Feeding.—The occasion may arise to nourish an infant partly on the breast and partly artificially. The first question to be decided is as to its advisability. If the woman's milk is to be obtained from a perfectly healthy woman who has an abundant secretion, there can be little doubt in most cases of the advantage of mixed feeding over wholly artificial feeding. However, when this is tried at a time when the mother's milk is giving out, its advisability must be gauged by the amount of milk secreted by the mother's breast. If this be so small that only sufficient is produced to make up two nursings in twenty-four hours, it is frequently necessary to remove the child from the breast entirely to prevent or to relieve a dyspepsia. (See Nutritional Disturbances in Breast-fed Infants.) In using mixed feedings, the amount and composition of the artificial food should depend upon the age, weight, etc., of the child; in general, the single feeding should correspond to that used in the normal infant under like conditions.

Under proper conditions the results obtained with mixed feeding are very desirable. Even a small quantity of good breast-milk each day undoubtedly raises the resistance of the child, and also seems to aid the digestive processes.

[1] Am. Jour. Dis. Child., 1915, ix, 381

CHAPTER IX

NUTRITIONAL DISTURBANCES IN THE BREAST-FED INFANT

INTRODUCTION

Nutritional disturbances are of very frequent occurrence in the breast-fed infant, but their nature is usually so mild that the physician is not consulted until they have existed for some time. Happily, in most instances, these minor disturbances cure themselves, *i.e.*, disappear without marked change in the method of nursing, but if they do continue, they infrequently cause irreparable damage. A chronic nutritional disturbance in a breast-fed infant may, on the other hand, at the time of weaning lead to serious consequences, which can only be accounted for by the history of a foregoing disorder.

Though starvation from too little food can scarcely be regarded as a nutritional disturbance *per se*, yet it should be well studied in order to know its symptoms and differentiate them from those of dyspepsia. In the nutritional disturbances of breast-fed as well as in those of artificially fed infants, Finkelstein's classification will be used: (1) Weight disturbance; (2) dyspepsia; (3) decomposition; (4) intoxication. For practical purposes the one which is encountered sufficiently often to be discussed separately is dyspepsia. Weight disturbance, decomposition and intoxication are so uncommon that their discussion will

be reserved for the discussion of these conditions in the artificially fed infant.

UNDERNOURISHMENT

This can happen under various circumstances. In the early weeks of lactation the breast-milk may give out without the mother's knowing it, and she may be surprised to find the child losing in weight. Inverted nipples may be the cause of the infant's not getting enough food, but this is usually anticipated, and the lack of breast-milk made up with artificial food. Heaney[1] mentions three causes of failure of the development of lactation; inability of the child to nurse properly; nervous condition of the mother; and the presence of but one or two ducts in the nipple. Harelip or cleft-palate may render it impossible for the infant to get the requisite amount of food.

Rosenstern[2] states that in 32 out of 50 hospital cases the cause of underfeeding was lack of appetite in the child. Barth,[3] however, says that it is not failure of appetite, but inability on the part of the child to nurse through the lack of co-ordination of the movements.

Kasahara[4] has made a study of the suction efforts of infants and finds them rather different in the newborn, in prematures, and in marantic babies from those of healthy older infants. Unquestionably, in many of these cases there is a distinct neuropathic taint.

Von Reuss[5] advises to distinguish between undernourish-

[1] Surg., Gyn. & Obst., 1915, xxi, 65.

[2] Deutsch. med. Wochenschr., 1912, No. 39.

[3] Zeitschr. f. Kinderheilk., 1914, x, 129.

[4] Am. Jour. Dis. Child., 1916, xii, 73.

[5] Zeitschr. f. Kinderheilk.. 1912, iv, 499.

ment and exsiccation. He enumerates the causes of undernourishment as weak suckling, lack of appetite, fear of the breast on the part of the child; and on the part of the mother, cracked nipples and deficient milk-supply.

The condition is not a common one. It occurs, perhaps, more frequently in the first few weeks of life, because at that time the mother is least able to nurse her infant. I do not believe that this ever results from an abundant milk-supply being "too thin." Galactorrhea may rarely be the cause.

Symptoms.—The first thing noticed is the failure of the infant to gain in weight or, perhaps, even a loss in weight. As to whether the weight remains stationary or falls, depends altogether upon the amount of food ingested. If this be about half the normal, then the weight usually remains stationary; while if it is practically nothing, there is a loss of weight.

The amount of food taken can be determined by weighing before and after nursing. A decrease in the amount taken from the breast does not by any means always indicate a deficient milk-supply. We must first exclude dyspepsia in the infant, for in the acute stages of dyspepsia the infant takes little or no milk from the breast. The breasts themselves are usually flabby, and the child, after being put to the breast, soon ceases to nurse, and often, in an exhausted state, falls asleep. These infants are, as a rule, not restless, sleep is deep and unbroken and crying is *not* a noticeable symptom. The cry is not sharp and piercing, but of a whining, piteous character, is not often repeated or continued for a long time. All this is especially true in the very young infant.

There is no vomiting or eructation of gas. The stools are few and scanty, often only stains on the diaper. They are usually brown, but may be greenish; no curds are found, but some mucus may be present. The urine is noticeably scanty.

The temperature is usually subnormal, sometimes markedly so, except in the early days of life, when there occurs what is known as *inanition fever*. In the writer's experience this has been very common. The temperature may rise to an alarming height, registrations of 105° or 106°F. not being unusual. Careful examination fails to reveal any focus of infection, and the fever disappears in a few hours after the infant is given food. Czerny and Keller[1] regard this as due to bacterial infection from the intestines, which is overcome by the change of the intestinal content. This is rendered unfit for the further growth of the bacteria at fault, by the ingestion of food. Von Reuss[2] does not think that the nourishment plays any part in the production of this fever, but thinks that we must take into consideration destruction of tissue, loss of water, and deficient warmth regulation in the newborn, while Heller[3] regards the condition as due to abnormal metabolic processes together with deficiency in warmth regulating functions. Peteri[4] believes it to be due to exsiccation. Grulee and Bonar[5] have recently investigated the subject of inanition fever and can find no evidence that the condition is due to exsiccation but think that the changes in conditions in the bowel

[1] Bd. ii, 198.

[2] Zeitschr. f. Kinderheilk., 1912, iv, 32.

[3] Zeitschr. f. Kinderheilk, 1912, iv, 55.

[4] Jahrb. f. Kinderheilk., 1914, lxxx, 612.

[5] Am. Jour. Dis. Child., 1921.

from meconium to milk content are responsible for the decline of the fever, since this regularly drops after the giving of food but not after the giving of water.

Undernourishment rarely reaches a severe degree. The skin may be somewhat flabby, the turgor reduced. Pallor is not a characteristic symptom, but weakness is usual. The heart-tones in the early stages are not affected.

Gismondi[1] states that while in the well nourished breast-fed infant the abdomen is frog-like, when there is insufficient nourishment the sides of the abdomen are more flabby and flattened. He thinks this is due to lack of content in the intestines.

Diagnosis.—The most distinguishing feature about these cases is the stationary or falling weight, with no symptoms of gastro-intestinal disturbance or discomfort. If, after repeated tests, the weighing before and after nursing shows but a small amount of food obtained, the evidence for undernourishment is strong, but dyspepsia must always be considered (which see). A failure to obtain any appreciable amount of food from the breast rarely if ever occurs in dyspepsia, and should be regarded as strong evidence that the failure to gain weight is due to an insufficient amount of food. The weight test will usually exclude those cases of exudative diathesis where, without apparent cause, in the first few weeks of life the children *fail to gain.*

Inanition temperature often offers great difficulties in diagnosis when first observed. One must think of the numerous infections which may occur, especially those most intimately connected with infection at the time of labor, such as septicemia, infected umbilicus, etc. In cases of

[1] La Pediatria, 1918, xxvi, 7.

inanition fever, the absence of symptoms which point to any general or local disturbance of the organism is most suggestive. The infant does not appear septic nor even very sick unless the temperature is excessive. Nothing is more striking than the fall of the temperature-curve after the ingestion of food. In a few hours the temperature drops to normal and remains there, unless there appears some disturbance of an entirely different nature.

A prolonged starvation may very closely simulate a severe marasmus, but this is certainly so uncommon in breast-fed infants that it need be only mentioned.

Prognosis.—This condition, if recognized, offers an absolutely good prognosis, unless it has existed for so long that through deficiency of food the organism has suffered material damage. This degree is extremely rare. It is, indeed, very questionable whether such a condition can exist.

Treatment.—The condition once recognized, the treatment, of course, consists in supplying food to the hungry infant. No greater precaution need be taken than one would exert in regulating the nourishment of a normal infant of the same age and weight. The inanition fever falls so quickly after the ingestion of food that other treatment of this symptom is unnecessary. In stimulating the flow of breast milk the Biers hyperemia pump may be applied for fifteen minutes each day (Heaney[1]) and after the infant has nursed the breast may be further emptied by means of the Caldwell[2] breast pump.

It should be mentioned here that in the majority of

[1] Surg., Gyn. and Obst., 1915, xxi, 657.

[2] Am. Jour. Dis. Child., 1915, ix, 381.

cases the best means to prevent the condition is the stimulation of the mammary gland in the first few days of life. Oftentimes the first week will determine whether or not a mother is to be able to nurse her baby. One of the chief causes of her inability to do so is lack of the proper stimulation of the breast by the suckling of the infant. Rather harsh measures at times are necessary in order to keep these babies awake long enough to carry out the required amount of stimulation, but every means should be tried to increase the flow in the first few days after the birth of the child, and the importance of this should be impressed upon the mother and her attendant.

WEIGHT DISTURBANCE

This condition is by no means a common one. The usual disturbance in breast-fed infants is dyspepsia, and this is not, as a rule, preceded by any determinable period of weight disturbance. Weight disturbance may, then, in the breast-fed infant be regarded rather as a short preliminary stage to dyspepsia, and as such will be discussed under that head. The weight disturbance when present is practically the same as that of the artificially fed infant (which see later), except that the tendency to severe constipation is usually lacking.

DYSPEPSIA

Dyspepsia is by far the most common and most important of all *nourishment* disturbances which occur in the breast-fed infant. It is not only the most common, but the most disagreeable, and in a large number of cases leads to removal of the child from the breast under circumstances which, with a little care and patience, could be easily remedied.

Etiology.—In studying the etiology of this disturbance we must keep in mind that woman's milk is that food for which the infant, in the great preponderance of cases, has the greatest tolerance. In proportion to the degree of tolerance for the given food must be the dietetic error which causes nutritional disturbance on that food. Hence in dyspepsia in the breast-fed child, as we would expect, the error is usually a gross one, and, therefore, more easily corrected.

The essential cause is overfeeding, whether this occurs by giving too much at a nursing or from nursing too often. It is unusual to see dyspepsia in a breast-fed infant to which the breast has been given at four-hour intervals ever since birth. This may be due to the fact that there is not an oversupply of milk, as it is to the inability of this child to overfeed on such regulation of food, but in the opinion of the writer, from close observation, the latter condition would seem to be the important one. We frequently see infants fed as often as every two hours, and even one hour, or one hour and a half. Many of these thrive and escape nutritional disturbance; most, however, at some period show dyspepsia of greater or less degree.

Nursing at irregular intervals is a frequent source of trouble, mostly because the irregularity consists, as a rule, in nursing the child when it cries. This cry is caused very often by colic, and the giving of food is the one thing which should not be done. A variety of dyspepsia usually of slight severity is found in children on mixed feedings. This seems to be due to the fact that the breast-milk when about to give out is not a fit food for the infant. Proof of this comes when the removal of the child from the breast

and complete substitution of artificial food is followed by a cessation of dyspeptic symptoms, as occurs in most instances.

As to whether any one element in the breast-milk can be regarded as the causative factor in this condition, it would be hard to say. The lactose, which is so potent a factor in the production of nutritional disturbances in the artificially fed infant, has received very little attention in the discussion of those of the breast fed, and very little is known in regard to its action under these circumstances. It would seem a very difficult task to estimate the value of this food-stuff in this relation.

It is easier to estimate roughly the effect of the fat. As has been pointed out, the last of the milk taken from the breast during a nursing period is rich in fat. It would seem, then, that if the infant were fed oftener the fat-content would be continuously higher, because at each nursing the gland would be drained. Again, if on long intervals the child showed no tendency to improve and the fat were regarded as a cause, a limitation of the time at the breast would reduce the amount of fat in the food, and hence cause an amelioration of the symptoms, which, in fact, does occur. On the other hand, although in both these instances the fat is that constituent which is most reduced, we must not forget that at the same time the total amount of food is reduced. We may say, then, that while there is little evidence that the other constituents of the breast-milk are the cause of nutritional disturbance, the position of the fat in that rôle is not conclusively proved, and that at present we must content ourselves with the simple statement that overfeeding of all constituents of the milk is the

cause of dyspepsia in the breast-fed infant, with suspicion pointing strongly to the fat as the chief source of disturbance.

Symptoms.—Undoubtedly, the symptom which most often is the reason for the mother's seeking the advice of a physician is "colic." Whatever the true nature of colic may be, it is a condition associated with severe pain, and this apparently is of gastro-intestinal origin. Usually in the earlier stages, which correspond to the lighter forms of colic, a sharp cry, repeated almost without interruption and continued over a longer or shorter period of time, is begun with a more or less definite relation in point of time to the nursing period.

Sometimes this occurs a few minutes, sometimes two or three hours, after nursing; sometimes both. When the attack comes on shortly after nursing there seems to be a predominance of stomach symptoms, since the eructation of gas frequently brings relief. Where the attack comes some hours after nursing, the intestinal tract seems to be more involved, since the expulsion of flatus sometimes brings relief, as does colonic flushing. When the interval between nursings is so short that the ingested food does not have time to reach the intestines before more is taken into the stomach, the attacks may mean a combination of both the stomach and intestinal irritation. The foregoing statements refer only to the earlier stages. In the later stages or severe cases the entire gastro-intestinal tract seems to be affected, and hence it is no longer possible to differentiate. A peculiar form of colic and one which is frequently seen is that in which the attack comes at a certain time each day, usually between 6 P. M. and

midnight. This attack usually lasts one to two hours, and perhaps can best be explained by the accumulation of irritant products in the gastro-intestinal tract following successive feedings at short intervals.

During the attack of colic the thighs are held flexed on the abdomen, the legs on the thighs, usually, at times, the child kicks. The abdomen is held rigid, the arms are often thrust out frantically, and the child will grab at whatever is within reach or even tear its face. The skin of the face and body is usually suffused with blood as the result of the exertion, although the extremities are cold. This latter fact has doubtless led to the fallacious idea, held by so many of the laity, that colic is the result of chilling. Frequently, previous to the attack the child is restless, expels more or less gas, and perhaps shows the so-called colic "grin." After the attack the infant is not so exhausted as would be expected; it, however, usually falls asleep. The sleep is light and subject to frequent interruptions, with crying and restlessness.

As to the pathologic condition which underlies this symptom-complex, little is known. Colic in the adult is perhaps best known as lead-colic, peritonitis, and postoperative "gas"-pains.

In all these conditions is a marked circulatory disturbance of the intestinal wall. This would seem to be the case in colic in infants. The coldness of the hands and feet is the result of internal congestion rather than itself a causative factor.

Though the most prominent and annoying of all the symptoms of dyspepsia in the breast-fed infant, colic is probably not so indicative of severe intestinal disturb-

ance as are those symptoms more intimately associated with derangements of the gastro-intestinal tract. Diarrhea is nearly always present. The stools are passed usually four to eight times in twenty-four hours. The feces are grass-green in color and contain mucus and curds in varying amounts. Much flatus is expelled, often preceded by crying. Occasionally constipation is found. In these cases the stool when passed is usually soft, often semifluid, so that the disturbance cannot be due so much to an increased consistency of the bowel-content as to a deficient peristaltic action.

Vomiting is very frequent in these cases of dyspepsia in the breast-fed baby. It may be a simple spitting, which may or may not gradually be transformed into a true vomitus. Vomiting in some form often precedes by some weeks the other active symptoms in many cases, and is a valuable symptom as a warning of approaching disturbance of a more severe degree. During the attack of colic, when eructation of gas is encountered, there is often forced up with the gas a considerable amount of food. The severity of the vomiting more than that of any other symptom depends upon the length of the interval between nursings. If this has been very short, the vomiting is more frequently severe; while if the interval has been long, there is either no vomiting or else it is only slight or occurs only at the onset of the trouble.

Distention is not a common symptom, in spite of the repeated passage of flatus.

The temperature shows greater variation than normally, and tends to be above normal rather than below. The temperature range is from about 97.6° to 100°F. Tem-

peratures above 100°F. are not common, and lead to the suspicion of a severe gastro-intestinal disturbance or a complication.

The skin is usually fresh and pink in the early stages, but if the condition has continued for some time the child becomes pale. Tissue turgor is perceptibly reduced only in the later stages, *i.e.*, if the dyspeptic condition has continued for some days or weeks.

In dyspepsia the heart-tones are not modified in character. The pulse is somewhat more rapid than normal. The character and rate of respiration are not perceptibly changed.

The urine very often has a strong ammoniacal odor, suggestive of a slight degree of acidosis.

Nervous disturbances are quite frequent. The child is cross and fretful and cries frequently, even though it has no colic. The sleep is light and disturbed, often lasting only an hour or two at a time, and then so light that at the slightest noise the infant awakes with a start. Convulsions are rarely met with, and if present can be ascribed to a spasmophilic diathesis, and are usually the result of some nourishment other than breast-milk.

Complications.—Perhaps the most common complication of this condition is nasopharyngitis, from infection of the lymphoid material in that region. This tends to prolong the gastro-intestinal disturbance by increasing very markedly the mucus which is swallowed, and which, in turn, acts as a gastro-intestinal irritant. The result of repeated attacks of this sort is, of course, the formation of adenoids, with, at times, attacks of acute otitis media. The primary dyspepsia probably acts only by lowering

the resistance. Coughing so frequently encountered in such cases of dyspepsia can probably best be explained in this way.

Continued overfeeding with dyspepsia in children with exudative diathesis results often in the appearance of a facial eczema or a seborrhea of the scalp, which is very resistant to treatment and exceedingly annoying. The appearance of such conditions as pneumonia, pyelocystitis, etc., during the course of a dyspepsia may be regarded as accidental, and are probably only in small measure the result of this. Dyspepsia may, however, complicate any of these conditions (which see).

Sequelæ.—The only sequelæ of any note are those which refer to the gastro-intestinal tract, and they are not common. Intoxication may occasionally occur, but it is more often due to an attempt to satisfy the child with some food other than the breast (usually sweetened water or condensed milk), and hence cannot be regarded as strictly a result of the breast nourishment. Decomposition is still less common, and is usually due not to the gastro-intestinal disturbance, but to some intercurrent affection which may have been overlooked.

Diagnosis.—The symptoms which are most suggestive of this condition are colic, diarrhea, vomiting, and slight temperature. Very important is the weight-curve. A marked gain in weight followed by a stationary period or loss is most conclusive evidence, since none of the conditions with which this may be confused is likely to show this peculiar curve.

Dyspepsia in the breast-fed infant must primarily be differentiated from underfeeding, with which it is very

frequently confused, leading to disastrous results. Colic is not present in underfeeding, and the cry, though occasionally accompanied by eructation of gas, and though at times rather persistent, never has the character of the cry from colic.

The weight-curve in dyspepsia, with its rapid rise and subsequent fall, is not to be found in underfeeding. Usually in dyspepsia the amount taken at a nursing is excessive, though in the acute stages it may be greatly reduced, due to nausea. In underfeeding the single nursing is always reduced in amount. The presence of diarrhea and vomiting are indicative of dyspepsia. A rise in temperature, though slight, is in favor of a dyspepsia, except in the first few days of life. Other conditions, such as nasopharyngitis, otitis media, pyelocystitis, pneumonia, etc., are likely at first to offer difficulties in diagnosis, but almost without exception the temperature in these conditions is higher than in dyspepsia, and their presence is revealed on careful examination by local findings.

Prognosis.—The outlook as to life is, almost without exception, good. Dyspepsia is a mild disturbance in the breast-fed infant in spite of some very annoying symptoms, but should receive prompt attention, not because of the danger while the child is on the breast, but because of the difficulties likely to be encountered when the infant is weaned. As in all other gastro-intestinal disturbances at this time of life, the younger the child the worse the prognosis, but in the breast-fed infant the chances of a decomposition following a dyspepsia in the first few weeks of life is very slight, especially in comparison to what occurs so frequently in the infant on the bottle. The duration

of a dyspepsia depends, first, upon the length of the interval between the first onset of symptoms and the institution of treatment, and upon the nature of the treatment itself. If proper treatment is instituted upon the first appearance of disturbance the child is usually well on the way to recovery within forty-eight hours. If, however, the symptoms have existed for some days or weeks, it is almost impossible to get an early cessation of symptoms. Of all the symptoms, colic is the most persistent and the one which resists longest to treatment, and its severity and duration is in direct relation to the duration of the dyspepsia itself. Long after all other symptoms have disappeared colic still persists, and only the most careful regulation of the diet will bring any relief.

Treatment.—Since this condition in due to too much food, the first indication for treatment lies in reduction of the food. As a prophylactic measure the observation of the four-hour interval between nursings from the very beginning of the lactation period is most gratifying in its results. While this does not insure against overfeeding, it at least allows the food to leave the stomach before new food is put into it, and thus removes one of the chief causes of discomfort.

After the dyspepsia has made its appearance, the first indication is reduction of the food and regularity in nursing. In the severer cases it may be necessary to give the child only barley-water (sweetened with saccharin, *not sugar*) for twenty-four hours. In these cases it is never well to continue this starvation diet longer, because of the danger of the breast-milk giving out. An interval of four hours during the day should be observed and the infant should be

fed once at night. These measures are by no means always sufficient. In most cases it is not only necessary to lengthen the interval to four hours, but also to limit the time at the breast to five or even three minutes each nursing. With so little stimulation the breasts are likely to cease to functionate well, so that the length of the nursing period must be increased as rapidly as possible. It is usually better to keep the child on the breast at all hazards, because, with careful attention to details, the ultimate result is nearly always satisfactory. Except in the treatment of colic no drugs are necessary in the treatment of dyspepsia; calomel certainly does no good and castor oil may do distinct harm. Bismuth and astringents are rarely if ever necessary, except in severe cases of vomiting.

Fresh air is an absolute necessity in all cases of dyspepsia. The child, even in the dead of winter, should be out-of-doors at least once a day. It should sleep in a room which has been thoroughly aired and has the window open all the time. Better results can be obtained if the child sleeps in the open air on a porch or balcony during the time of its daily nap.

Every precaution should be taken against chilling in cold weather, and one should be at least as careful against overheating in hot weather.

Careful bathing daily, with an alcohol rub following, is to be advised, as well as careful attention to nostrils and mouth. Hygienic measures alone are of great importance in the treatment of these cases, and should be definitely commanded by the attending physician.

Symptomatic Treatment.—Few symptoms need special mention, since most clear up on the general treatment above indicated.

If the vomiting is persistent and severe, stomach washing is often of great benefit. This is very easy in a young infant. The apparatus used consists of a small glass funnel and a male catheter (size 18 or 20 French). If a glass funnel cannot readily be obtained, the barrel of a large piston-syringe is admirably suited. All apparatus should be thoroughly cleaned and sterilized before using. The infant is placed on its back on the table and the arms secured; the abdomen bared, so that any distention of the stomach may be noted. The tube is then moistened with water, introduced into the pharynx, and gently pushed downward. When the stomach is reached a small amount of fluid or mucus rises into the funnel. As a general rule, plain sterile tepid water is best for stomach washing. The amount should always be carefully measured. The water is then slowly introduced into the funnel, and when signs of regurgitation or distention appear, is siphoned off, and the process repeated several times.

It is often remarkable how much good one such stomach washing will do. It is, however, often necessary to repeat it, but, as a rule, not oftener than once a day. If this is not successful, bismuth may be given. This is best given in an acacia mixture to the amount of 2 to 3 grains to a dose, repeated every four hours, or given fifteen to thirty minutes before or after feeding, depending on whether the vomiting occurs immediately after nursing or some time after.

Diarrhea is slight and needs no special attention. Eructations and flatus are in all cases closely allied with colic, and as such will be discussed under that head.

Of all the symptoms of dyspepsia in the breast-fed infant, *colic* is the most annoying and the most resistant to

treatment. The measures directed against the affection in general, such as reduction of food or starvation diet and hygienic treatment, not infrequently bring about the cessation of colic, but in another group of cases it seems almost impossible by any means in one's power to reduce the severity and number of attacks. Before directing treatment against the colic itself, one should be sure that this alone is to blame for the crying of the child. A spoiled child when refused attention may set up such a cry as to closely simulate colic. In such cases the thing most to be desired is discipline; nor can we expect to get results in a few days even by the most rigid attention to rules. Again, the syphilitic cry, as described by Sisto,[1] may be a source of error, and the condition be relieved by mercurials. Yet, after all these have been considered, we must admit that a majority of these cases are essentially colic and must be treated as such.

Two distinct types of colic can be recognized: one in which the symptoms appear to be due to accumulation of gas; the other, where the underlying condition is a spasm of the intestinal wall. Though an apparently different condition, the latter is really only a more severe circulatory disturbance of the wall of the alimentary tract than the former. That condition where gas is predominant shows first a tendency to accumulation of gas in the stomach. To expel this gas the child can be held to the shoulder or placed on its stomach across the lap, in which positions it most easily raises the accumulated gas. For this condition stomach washing and a long interval between nursings, with a limitation of the time at the breast, in

[1] Arch. de Med. d. Inf., 1910, xiv, 589.

Fig. 6.—Method of giving colonic flushing.

order to reduce the fat, will eventually bring complete relief. Where the gas is in the intestine, as evidenced by the passage of flatus, relief is best obtained by colonic flushing: the tube should pass well up into the colon and water at about 98°F. be used. Since the underlying condition is probably a congestion of the intestines, the blood should be brought to the surface by means of hot applications to the extremities and, perhaps, turpentine stupes.

In some cases when one is giving a flushing the intestines seem to come down and grasp the tube, then relax, allowing the tube to pass on; this undoubtedly is due to a spasm of the musculature. If the means given above fail to relieve this, one must resort to sedatives, and none of these are of any avail except opium. All care possible must be taken in the dosage of this drug; since infants are peculiarly susceptible to its action. Holt advises doses as shown in the following table, but in the experience of the writer somewhat larger doses have proved safe, and were necessary in order to control the pain.

At times hot water and peppermint-water seem to do

Preparations used	One month	Three months	One year	Five years
Paregoric	♏j	♏ij	♏v to x	♏xxx to xl
Deodorized tincture	♏1/20	♏1/10	♏1/4 to 1/2	♏ij to iij
Dover's powder	gr. 1/20	gr. 1/10	gr. 1/4 to 1/2	gr. ij to iij
Morphin	gr. 1/1000	gr. 1/600	gr. 1/200	gr. 1/30 to 1/20
Codein	gr. 1/300	gr. 1/200	gr. 1/60	gr. 1/10 to 1/8

good, but their action is so transient and irregular as to allow some doubt as to their efficacy. In many cases recently the writer has had good results by attempting to

overcome the excessive fermentation by administration of powdered casein and cultures of lactic acid bacilli. The casein is given to the amount of 1 gm. (moistened with a little water) just before nursing. One third tube of a liquid culture of the lactic acid bacillus is given twice a day.[1]

OTHER NUTRITIONAL DISTURBANCE

Decomposition or marasmus is very rare in breast-fed infants as a result of gastro-intestinal disturbances *per se*, but may occur as a result of intercurrent affections, though this is not common. Its discussion will be reserved for those chapters on artificial feeding.

Intoxication is likewise rare, and will be taken up in the same way.

[1] Grulee: Jour. Am. Med. Assoc., 1920, lxxv, 1701.

PART III

ARTIFICIAL FEEDING

CHAPTER X

FOODS USED IN ARTIFICIAL FEEDING OF INFANT[1]

In the artificial nourishment of the infant that food which is most important is milk. In the majority of cases cows' milk is the only one to be considered, though in some places goats' milk is used in rather large quantities, and in others mares' or asses' milk is occasionally used. Though other milks may be of some interest, cows' milk is, by all means, the most important and, therefore, deserving of our greatest attention.

COWS' MILK

Requisites for a Good Cows' Milk.—While it is always desirable to meet ideal conditions in respect to the proper precautions to be taken in procuring a good cows' milk, still it is very frequently impossible to do so. The attempt may be disastrous in two ways: first, it may raise the price of milk so high as to make it a hardship for poor parents to buy it for their babies; and second, which is of much graver consequence, the publicity involved in obtaining an ideal supply of milk for a large community may cause the more ignorant classes (therefore those to whom the

[1] For a more exhaustive work on milk, etc., see Hygienic Laboratory Bulletin, No. 41.

most infants belong) to refuse to give an impure milk to their babies, and resort to the disastrous expedient of attempting to nourish them on some such foods as condensed or malted milk. For these reasons it seems to me that we will attain our ends with much more certainty and with much less loss of life if we work by evolution rather than by revolution, remembering that while clean milk is very desirable when feeding infants, there are other problems of far greater value which can be solved with the means in our possession.

The secret of good cows' milk lies in cleanliness and in the health of the herd. The best milk is herd milk, because of the greater regularity in the percentage of the various constituents. As a rule, it is better that the cows should not be Jerseys, because of the delicate constitution of the breed, hence predisposing to tuberculosis, and because of the high fat-content, which is not desirable.[1] Every cow furnishing milk for infant feeding should be tuberculin tested. This is an extremely hard law to enforce in some communities, but every precaution possible should be taken in this direction. The stable in which the cows are kept should be on high ground, away from pig-pens, chicken-yards, etc., and should have good flooring, preferably cement; it should be well ventilated and lighted, and so constructed that it can be thoroughly and easily cleaned. The cows themselves should be kept clean and the udders washed well before each milking. The food should never consist of brewery refuse, etc.

It is very important that the milker be healthy and clean in his person. We should be sure that he has no infectious

[1] Washburn and Jones: Bull. No. 195, Vermont Agric. Sta., 1916.

Fig. 7.—Interior of model cow stable (Arcady Farm, Lake Forest, Ill.), from which is obtained certified milk for use in the larger cities.

disease, such as tuberculosis, typhoid fever, diphtheria, scarlet fever, etc. Where possible, he should wear clean white linen for milking, should wash the hands thoroughly, and be careful not to handle any articles unnecessarily. All these precautions can be taken by any reasonably intelligent individual, and will add greatly to the cleanliness of the milk.

The milk should be collected in utensils which have been sterilized or at least scalded, immediately cooled and sealed, and kept in this condition until delivery. These precautions are especially necessary if the distance of transportation is long.

Perhaps the greater factor in procuring a good milk for infants' use is the period of time which elapses between milking and delivery. In large cities this is seldom less than twenty-four hours, and hence unusual precautions must be taken in order to deliver a sufficiently pure milk. The shorter this period, *ceteris paribus*, the cleaner the milk, *i. e.*, the lower the bacterial count. At the time of consumption the number of bacteria per cubic centimeter should not be over 20,000 to 30,000, preferably not over 10,000. In the larger communities this is rarely possible, and, except in the certified milks, a count of several hundred thousand is more often found. The milk must be free from all pathogenic micro-organisms.

Milk for the infant must be free from preservatives and all other artificial contaminations. It must have a stable percentage of the various constituents, especially must the fat (the most variable of all constituents) be 3.5 to 4 per cent. If the precautions above cited are taken, we will obtain a milk sufficiently good so that we may ascribe any

nutritional disturbance in the infant not to decomposition of the milk, but to errors in diet or to constitutional affections.

Chemical Composition and General Characteristics of Cows' Milk.—Cows' milk has a specific gravity of 1.027 to 1.035. Immediately after milking it is amphoteric; later, distinctly acid. The acidity is primarily due to the acid phosphates and carbonic acid, and secondarily, to decomposition of the milk-sugar by the bacteria of the milk.

The chief constituent of milk is water. Of the organic materials, fat, protein, and carbohydrate are present. The fat is chiefly in the form of olein, palmitin, and stearin, with some of the volatile acids. The protein-content consists in large part of caseinogen, with a smaller quantity of lactalbumin, a trace of lactoglobulin, and some other proteins. The carbohydrate is practically all in the form of lactose.

The inorganic constituents consist of phosphates, sulphates, chlorin, calcium, magnesium, sodium, potassium, and iron. A small amount of citric acid is found.

The schemes of Van Slyke and of Babcock, as shown in the Hygienic Laboratory Bulletin, No. 41, p. 314, show graphically the various constituents and their percentages:

VAN SLYKE

	Water, 87.1			
		Fat, 3.9		
	Solids, 12.9	Solids, not fat, 9.0	Nitrogen compounds, 3.2	Casein, 2.5
Milk, 100	100.0	——	Milk-sugar, 5.1	Albumin, etc., 0.7
		12.9	Ash (salts), 0.7	——
			——	3.2
			9.0	
	Gases,	Carbon dioxid. Nitrogen. Oxygen.		

BABCOCK

Milk, 100
- Butter-fat, 3.6
  - Glycerids of insoluble and non-volatile acids.............3.3
    - Olein
    - Palmitin
    - Stearin
    - Myristin
    - Butin (trace)
  - Glycerids of soluble and volatile acids.....................0.3 — Fat, 3.6
  - 3.6
    - Butyrin
    - Caproin
    - Caprylin (trace) — Total solids, 12.7
    - Caprinin (trace)
- Milk-serum, 96.4
  - Containing nitrogen............3.8
    - Casein.........3.0
    - Albumin.......0.6
    - Lactoglobulin, Galactin, Fibrin (trace) — 0.2
    - 3.8 — Solids,
  - Milk-sugar.................4.5 — not fat, 9.1
  - Citric acid..................0.1
  - 12.7
    - Potassium oxid. 0.175
    - Sodium oxid....0.070
    - Calcium oxid...0.140
    - Magnesium oxid 0.017
    - Iron oxid.......0.001 — Ash. 0.7
    - Sulphur trioxid. 0.027
    - Phosphoric pentoxid......0.170 — 9.1
    - Chlorin.........0.100
    - 0.7
- Water.. 87.3

100.0

For *general use* we may regard the fat as present in 3.5 to 4 per cent.; the protein, 3.8 to 4 per cent. (casein, 3 per

cent.; albumin, .4 to 1 per cent.); the milk sugar, 4 to 4.5 per cent.; the salts, about .7 per cent.

COMPOSITION OF MILK OF DIFFERENT SPECIES[1]

	Cow's milk, per cent.	Goat's milk, per cent.	Human milk, per cent.
Fat	3.90	3.80	3.30
Milk sugar	4.90	4.50	6.50
Proteins, combined with Ca	3.20	3.10	1.50
Salts	0.901	0.939	0.313
Di-calcium phosphate	0.175	0.092	0.000
Tri-calcium phosphate	0.000	0.062	0.000
Mono-magnesium phosphate	0.103	0.000	0.027
Di-magnesium phosphate	0.000	0.068	0.000
Tri-magnesium phosphate	0.000	0.024	0.000
Mono-potassium phosphate	0.000	0.073	0.069
Di-potassium phosphate	0.230	0.000	0.000
Potassium citrate	0.052	0.250	0.103
Sodium citrate	0.222	0.000	0.055
Potassium chloride	0.000	0.160	0.000
Sodium chloride	0.000	0.095	0.000
Calcium chloride	0.119	0.115	0.059

In addition to the constituents cited above, the milk contains a number of enzymes (diastase, galactase, lipase, salol-splitting ferment, oxidizing ferments, *i. e.*, catalase and peroxidase, reductase). The function, if any exists, of these substances is unknown. Whether if rendered inactive (*e. g.*, by heat) the effect is deleterious, is as yet not known.

Much has recently been written about vitamines, especially about vitamines in milk. Whatever these substances are they seem to be present in abundant quantities in milk obtained under proper conditions and prepared in the proper way. It is quite likely that the cow does not elaborate vitamines but obtains them from the food and as a conse-

[1] Bosworth and Van Slyke: Jour. of Biol. Chem., 1916, xxiv, 187.

quence vitamines are to be found more abundantly in milk from cows who have been fed green fodder. The standing of milk over a long period reduces the quantity of vitamines. It is altogether likely that boiling milk is less destructive of vitamines if carried out over only a short period than is pasteurizing which requires, if it is to be effective, 20 to 30 minutes.

Bacterial Content of Milk.—The number of bacteria in milk is an index on its freshness, and the precautions taken in milking and marketing the product. A count of over 100,000 bacteria per cubic centimeter is certainly not fit for use in nourishing the infant, but a count of 10,000 or below is desirable. The bacteria may be divided into two classes—pathogenic and non-pathogenic. In the former group may be placed such organisms as the tubercle bacillus, the typhoid bacillus, and the diphtheria bacillus. Milk containing these organisms is a direct source of danger to the individual to whom it is supplied as food, hence their presence is definitely detrimental and should be prevented in all milk supplied to infants. Rosenau[1] has determined that by heating the milk to 60°C., and maintaining it at that temperature for twenty minutes, these and all other pathogenic organisms likely to be present are destroyed, and the milk is rendered free from the possibility of contagion from these.

The non-pathogenic bacteria, such as staphylococci, streptococci, lactic acid bacilli, etc., are a source of danger, not because of their direct action upon the human organism, but because of their decomposing action on the milk itself, which renders it unfit for use. As to just what the

[1] Hygienic Lab. Bull., No. 42.

substances thus formed are which cause the difficulty it is not definitely determined, but, in all probability, the fatty acids are largely to blame. The vast bulk of the bacteria in average milk is made up of such organisms, and the bacterial count is an estimate of their number and, to a great degree, of their activity, since the process of growth is directly dependent on their biologic characteristic of being able to decompose and assimilate the milk constituents. Whether the foreign protein introduced in the milk by their enormous increase is deleterious to the human body is a subject for future investigation. Fleischner and Meyer[1] found B. abortus almost constantly in the certified milk of San Francisco.

Adulteration of Milk.—Adulteration of milk is carried on in three ways: first, by thinning the milk; second, by thickening the milk; third, by addition of preservatives or coloring-matter. Thinning the milk is accomplished by either skimming or watering. Though highly undesirable and palpably fraudulent, so far as the infant is concerned, these processes are not dangerous, so long as they are carried on in a sterile manner. Thickening of the milk is seldom resorted to, and deserves no further attention. Coloring matters are sometimes used in thinned milk to give the idea of higher percentage of solids. Of all means of adulteration, that most important, from our standpoint, is the addition of preservatives. These in themselves may be dangerous, and by their addition they keep down the bacterial count in a milk which may contain much harmful sediment, such as pus and manure. Of the milk preservatives, formaldehyd, borax and boric acid, and sodium bi-

[1] Am. Jour. Dis. Child., 1917, xiv, 157.

carbonate are most frequently used. It is probable that these preservatives, in the dilution usually employed, have little or no effect on digestion, but at the same time a milk which it is found necessary to "preserve" in this fashion must primarily be contaminated, and is, therefore, unfit for use. Milk may be preserved with hydrogen peroxid by a method reported by the writer[1] which when used in infant feeding shows no apparent ill effects.

Sediment of Milk.—The sediment of milk consists of two sets of constituents, those of the milk proper and foreign material. The latter consists principally of manure, etc., and is the more abundant the more unhygienic the conditions under which the milk is obtained. Of the former, fat-globules and bacteria constitute a considerable portion.

Epithelial cells and an occasional leukocyte are likely to be present in any specimen of milk. Pus-cells in great abundance are strongly indicative of inflammation of the udders, and the herd should be carefully investigated in order to eliminate such contamination.

Lewis[2] states that if the sediment be studied with the use of a good blood-stain the following constituents will be noted: Epithelial or endothelial cells, polymorphonuclear neutrophiles, eosinophiles, lymphocytes, and red blood-corpuscles. He thinks that clumps of polynuclears and eosinophiles together with long chain streptococci mean mammary gland trouble in the cow. Absence of streptococci, however, does not mean that such is not present.

"Germicidal" Action of Milk.—In plating-out milk to

[1] N. Y. Medical Jour., 1916, civ, 1920.

[2] Amer. Jour. Dis. Child., 1913, vi, 225.

make a bacterial count it has been noticed that the fresh milk gives more colonies than does that which has stood a few hours. At first it was concluded that this meant a reduction in the number of bacteria, and hence a certain germicidal property of the milk. Rosenau has shown, however, that the reduction is only apparent, and is, in fact, due to the presence of agglutinins causing many bacteria to produce but one colony. This agglutination is often specific in its action, acting on one group of bacteria but not on another. That the milk in the fresh state, however, possesses some inhibitive action on bacteria is shown by boiling, after which the bacterial growth is much more rapid than before.

Pasteurization and Sterilization of Milk.—For the purpose of eliminating the danger (direct or indirect) of bacterial action, heating the milk has been resorted to. The simplest form of doing this is by pasteurization, in which process the milk is heated to 60° to 65°C. (140°–150°F.) for thirty minutes. If no thermometer is at hand, a sufficiently accurate temperature may be had by heating the milk until a scum forms on it, and maintaining it at that temperature for the time mentioned. Pasteurization kills all the pathogenic bacteria and from 98 to 99 per cent. of the other bacteria. After pasteurization there is less inhibition to bacterial growth than in raw milk. The chemical changes in the milk, so far as known, are unimportant (Rupp).[1] Commercial pastéurization is not, as a rule, to be trusted, because it may be carried out on very bad milk, and then be inadequately done. The time of delivery, too, may be so long after the heating that bacterial growth is

[1] U. S. Dept. Agric. Bull., No. 166.

very great. Ford[1] found that milk heated to 80° to 85°C. for 20 to 30 minutes and kept at 37°C. decomposes with the elaboration of definite poisons which are similar or possibly the same products which are found in milk cultures of the B. aerogenes capsulatus.

Sterilization consists in boiling the milk for from five to twenty minutes. By doing this we destroy all bacteria and their spores, but at the same time we destroy the power of the milk to inhibit their growth, and any contamination will be followed by marked increase of the number of bacteria in a few hours. The chemical changes produced by sterilization are very marked. Czerny and Keller enumerate them as follows:

1. The milk-sugar is caramelized under the formation of acid (lactic acid).
2. The coagulated casein and albumin are brought by the acid to an early precipitable condition.
3. The rennet action on milk is very much impaired through the fact that the calcium salts are in part rendered insoluble.
4. The milk gases, especially carbonic acid, are expelled.
5. The ferment action of the milk is destroyed.
6. The fat in part separates from its emulsified state.
7. The lecithin is split up and the other organic phosphorus combinations of the milk are more or less changed into inorganic.
8. Boiled milk undergoes putrefaction, raw milk does not.
9. The taste of the milk is disagreeably changed.
10. The antiseptic and antitoxic properties of the milk are lost.
11. Hydrogen sulphid is recognizable if the milk is boiled longer than five minutes.

According to the investigations of Lane-Claypon[2] there is no scientific or practical reason for believing that in infant

[1] Am. Jour. Dis. Child., 1919, xviii, 199.

[2] Report to Local Government Board, New Series, No. 63, London, 1912.

feeding boiled milk is in any way inferior to raw. This opinion is confirmed by the work of Daniels, Stuessy and Frances.[1] Brennemann[2] has recently very ably championed boiled milk in infant feeding. The experience of Brennemann[3] goes to show conclusively that the curd from raw milk is much harder and larger than is that from boiled milk.

MILK POWDER

In the last few years very much has been written about the use of dried milk in infant feeding. This milk is prepared by spraying the milk on to a hot drum by which all of the moisture is almost immediately evaporated and the remainder forms a fine white powder. The composition of this powder, of course, depends altogether upon the composition of the milk used in its preparation. It has the advantage that it may be kept for a long time and transported long distances and hence was a great aid many times during the war and immediately after when milk was so hard to procure in many of the countries of Europe. It is claimed by some that it is of special value in infant feeding but it is rather hard to see why this should be true.

CONDENSED MILK

This is prepared by evaporation of milk *in vacuo.* To some preparations cane-sugar in large amounts is added. This latter is known as the "sweetened" variety, and is that most used in infant feeding. In its preparation 1¼ pounds of cane-sugar are added to each gallon of milk and the whole evaporated. The finished product has a density

[1] Am. Jour. Dis. Child., 1916, xi, 45.

[2] Jour. Am. Med. Assn., 1916, lxvii, 1413.

[3] Jour. Am. Med. Assn., 1913, lx, 575, and Arch. of Ped., 1917, xxxiv, 81.

of about 1.28, weighs one-third of the original, and is $\frac{3}{11}$ of its volume, *i. e.*, 1 gallon of milk makes $2\frac{1}{4}$ pints of condensed milk. (Sometimes commercial glucose is substituted for the whole or part of the cane-sugar.) The product thus obtained is not sterilized, since the concentration is so great that bacteria do not grow, and since most of the bacteria have already been killed in the process of evaporation *in vacuo.* The composition of sweetened condensed milk is approximately as follows:

Water	24 to 30 per cent.
Fat	0.36 to 1 per cent. if made from separated milk. 9 to 11 per cent. if made from whole milk.
Milk-sugar	14 to 16 per cent.
Cane-sugar	32 to 41 per cent.
Proteins	9 to 12 per cent.
Ash	2 to 2.5 per cent.

The caloric value for that made from separated milk is about 55 calories per ounce, for that made from whole milk about 85 calories per ounce.

The unsweetened product is prepared in the same way, but without the addition of sugar. It must be sterilized to be properly preserved. The composition is about as follows:

	Per Cent.
Water	62 to 69
Fat	9 to 12
Milk-sugar	13 to 15.5
Proteins	9 to 10
Ash	1.6 to 2.3

Caloric value, about 58 calories per ounce.

In considering condensed milk as a food for infants many disadvantages can be noted. The process denaturizes. the milk, thus robbing it of one of its properties the importance of which for infant feeding is not as yet clear. From a commercial standpoint it will be readily recognized

by one who will stop to think that in order to make the sale of condensed milk profitable a very inferior grade of milk must be used. The presence of cane-sugar in such large amounts and the low fat-content in so many of the condensed milks on the market give a food which in its composition is anything but desirable. In examining the sediment of condensed milk as obtained by high-speed centrifugalization, McCampell[1] was able to determine that large quantities of manure were present, and that in at least some of the specimens tubercle bacilli could be demonstrated by staining and inoculation experiments.

WHEY

Whey is prepared by the addition of rennet to the milk, which is kept at a temperature of about 40°C. (100°–105°F.) for an hour to an hour and a half, then strained through a sterile cloth. The fluid is the whey. (If the whey is not desired and a fine soft curd is sought, it is better to use chymogen (Armour & Co.), a teaspoonful to the quart, and allow to drain for an hour to an hour and a half). The chemical composition of whey is, according to Holt's table,[2] as follows:

WHEY

	Average 46 analyses (Koenig)	From whole milk (Adriance)	From fat-free milk (Adriance)
Protein	0.86	0.94	1.17
Fat	0.32	0.96	0.04
Sugar	4.79	5.49	5.36
Salts	0.65	0.48	0.52
Water	93.38	92.13	92.91

[1] Personal communication. Work done in Bacteriological Laboratory of Ohio State University.

[2] Diseases of Infants and Children, 1906, 161.

If a fine curd is desired it is better to boil the milk before the rennet is added and then continue as above (Brennemann).[1] (See also Albumin-milk.)

The best carbohydrate fluid in which to suspend curds is a rather thick arrow-root water ($1\frac{1}{2}$ tablespoonfuls to the quart of water).

Whey has been used rather extensively by the followers of the percentage method, with the idea that the protein, which consists largely of lactalbumin, is more easily digested than is the casein. In this treatise very little if any use of whey will be advised, but more notice will be taken of the curd, for reasons to be given later.

PEPTONIZATION

This is much less used than formerly, due to the decided change of opinion in regard to the harmfulness of the protein. According to the idea of the writer it is never necessary. If it is desired to peptonize milk one should add the tube of pepsin to the amount of milk designated in the directions (usually 1 pint or 1 quart), allow to stand at 40°C. (100°–105°F.) for twenty minutes if complete peptonization is needed, then bring to a boil or keep on ice. One can regulate the amount of peptonization by decreasing the length of time for the action of the ferment to ten, five, etc., minutes.

CHANGE OF FAT-CONTENT

For changing the *fat*-content of the food, cream may be added to the milk mixture. *Cream* is designated as 12, 16, 24, or 32 per cent., according to the fat percentage. *Fat-free* or *skimmed* milk is prepared either by removing the

[1] Amer. Jour. Dis. Child., 1911, i, 341.

gravity cream or by centrifuge. The latter means is the most satisfactory. In all skimmed milk a certain amount of fat still remains. In the centrifuge variety this amounts to 0.2 to 0.3 per cent., while in that prepared by the removal of gravity cream it may amount to 1 per cent. or even more. All commercial skimmed milk is prepared with the centrifuge. Gerstenberger and his co-workers[1] advise the use of fats other than milk fats because by the proper combination a fat in its chemical characteristics similar to that of breast milk can be obtained. Their fat mixtures are as follows:

	Lard, per cent.	Cocoa oil, per cent.	Cod liver oil, per cent.	Cocoa butter, per cent.
G. R. No. 2........	86.00	14		
G. R. No. 3........	74.88	14	11.11	
G. R. No. 4........	63.78	14	11.11	11.11
G. R. No. 5........	74.88	14	.....	11.11

All fats are homogenized.

HOMOGENIZATION

Homogenization consists in an emulsification of the milk-fat with the idea of reducing the larger fat-globules of cows' milk to the same size of the fine globules in women's milk. For this purpose special machines are used. Birk,[2] after a trial of this, comes to the conclusion that for well and sick in ants it possesses no advantage over milk not so treated.

BUTTERMILK

Buttermilk has been extensively used both in this country and abroad. To 1 quart of fat-free milk about 8 ounces of

[1] Am. Jour. Dis. Child., 1915, x, 249.

[2] Monatsschr. f. Kinderheilk., 1908, vii, 129.

water is added, and a tablet of lactic acid bacilli is crushed and dropped into the mixture, the whole being allowed to stand for twenty-four hours at room temperature, at the end of which time it is ready for use. There seems to be little difference in the action of the various preparations of lactic acid bacteria (Heineman).[1] If one wishes to continue the preparation, it is well to do so by transfering a teaspoonful of the buttermilk each day. This seems to give a somewhat more even result. In spite of the greatest care contamination will occur, so that it is always advisable where possible to run two cultures at the same time.

Composition of Buttermilk[2]

Water	90.62
Casein	3.78
Fat	1.25
Milk-sugar	3.38
Lactic acid	0.32
Ash	0.65

ALBUMIN-MILK

Finkelstein and Meyer advised a mixture to be used under certain conditions which they have termed albumin-milk (Eiweissmilch). This consists in mixing the curds of 1 quart of whole milk with 1 pint of buttermilk made from skimmed milk, and making the whole up to 1 quart with water. By doing this they have a protein-rich, sugar- and salt-poor food, the fat quantity being relatively large. The difficulties in preparing this food are great, and lie in two directions: first, it is hard to procure a curd so fine that it will not settle to the bottom of the mixture and clump; and, second, the buttermilk is rarely a stable product for weeks in succession.

[1] Jour. Amer. Med. Assoc., 1909, lii, 372.

[2] Blythe, Foods and Their Composition, London, 1909.

The writer advises the following method: The milk may or may not be boiled for five minutes; if boiled, it is cooled, and chymogen (Armour & Co.), a teaspoonful to the quart, is added. This is allowed to stand one hour at 40°C. (100°–105°F.), and is then strained through a sterile cheese-cloth bag, and allowed to drip for one and one-half hours. It is then pressed through a colander three times together with the buttermilk, water added to the required amount, and beaten vigorously in a small churn. In giving this milk, if there is a tendency to clumping, the whole should be shaken well, after which the bottle should be placed in warm water only long enough to take the chill off the milk; any more vigorous heating will cause the curds to clump at the bottom of the bottle in large masses.

Composition of Albumin-milk

	Finkelstein and Meyer	Birk
Protein	3.0 per cent.	1.9 to 2.6 per cent.
Fat	2.5 per cent.	0.9 to 2.7 per cent.
Milk-sugar	1.5 per cent.	Average 1.3 per cent.
Ash	0.5 per cent.	High 3.6 per cent.

Courtney and Fales[1]

	Per cent.
Protein	3.6–4.0
Fat	3.0–3.5
Sugar	1.8–2.0
Ash	0.65

Two modifications of albumin-milk have been tried. The one known as protein milk (Wilcox, Hill, and Hoobler[2]) varies, in that instead of whole milk fat-free milk is used for the curd. The casein enriched cows' milk of Heim and John[3] is prepared by the use of a pint of whole milk instead of a pint of buttermilk.

[1] Am. Jour. Dis. Child., 1915, x, 172.

[2] Am. Jour. Dis. Child., 1913, v, 297.

[3] Zeitschr. f. Kinderheilk., 1912, iv, 1.

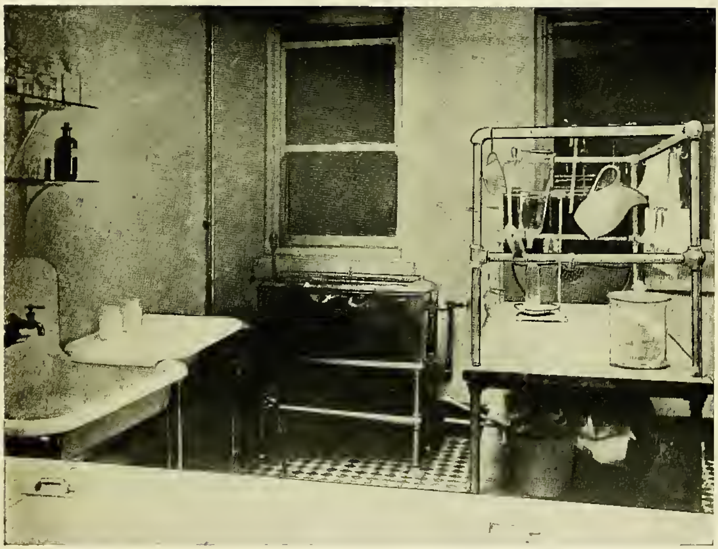


Fig. 8.—Infants' diet kitchen for small hospital; of much service in preparing more complicated formulæ (Provident Hospital, Chicago).

BUTTER MEAL PREPARATION

Czerny and Kleinschmidt have used a preparation of butter, wheat flour and sugar in feeding their cases of disturbed nutrition. This is prepared as follows: To 100 c.c. of warm water is added 7 grams of salted butter, 7 grams of wheat flour and 5 grams of cane sugar. This is boiled, stirring vigorously with a wooden spoon until it foams and the odor of butyric acid appears; then the required amount of milk is added and stirred up with the butter. This is then put on an asbestos plate and heated with constant stirring over a slow fire until the mass becomes light brown and perfectly fluid. To this is then added warm water and the sugar required. The whole is then boiled and passed through a fine sieve and to this while yet warm is added a measured quantity of boiled and cooled milk. Quantity advised for children under 3000 grams (6 lbs.),a mixture of 1/3 milk and 2/3 buttermeal; for those over 3000 grams (6 lbs.) 2/5 milk and 3/5 buttermeal.

CALORIC VALUES

	Calories
1 ounce whole milk (4 per cent.)	21
1 ounce cream (16 per cent.)	54
1 ounce fat-free milk	11
1 ounce buttermilk	10
1 ounce whey	5 to 6
1 ounce albumin-milk	13

Of the *other milks* used in infant feeding, that of the goat is most often mentioned in this country. Goats' milk has been advised because of its high fat-content and the high resistance of that animal to tuberculosis.

The composition varies greatly in goats of different

breeds. From Czerny-Keller's tables the following is collected:

	Per cent.
Total protein	2¼ to 4¼
Fat	2 to 7
Milk-sugar	2 to 5
Salts	½ to 1

Asses' milk is certainly but little used, if at all, in this country. Its chief chemical characteristics are a low protein- and fat- and a high sugar-content.

CARBOHYDRATES

Next in importance to milk and its derivatives, for the food of the infant, are the various carbohydrates. These may be divided into two main classes—the sugars and the starches. Of the more commonly used starches and sugars the ounce weight may be determined conveniently as follows in the form of level teaspoonfuls:

Milk-sugar	9
Dextri maltose	10
Mellin's food	11
Horlick's food	11
Flour Ball	12
Barley-flour (Robinson)	15

The following table of the composition of the various sugars and starches and the caloric value of each is compiled from Bulletin No. 28, United States Department of Agriculture, Office of Experiment Station. The amounts here given are of especial value because they represent determinations made on material purchased in open market:

	Water	Protein	Fat	Carbohydrates	Ash	Calories per ounce
Milk sugar (Merck)[1]...	....	....	...	100.0	...	117.0
Cane-sugar............	....	....	...	100.0	...	117.0
Barley flour...........	11.9	10.5	2.2	72.8	2.6	102.5
Oatmeal..............	7.3	16.1	7.2	67.5	1.9	117.0
Rice flour.............	8.5	8.6	6.1	68.0	8.8	102.5
Wheat flour...........	13.8	7.9	1.4	76.4	0.5	102.0
Arrow-root flour.......	2.3	....	...	97.5	...	113.0

Malt-sugar is not used in the pure state. In place of pure malt-sugar malt foods and malt-extracts are used. It is not at all certain that the action of malt-extract is due entirely or in large part to the presence of malt-sugar, as at first supposed by Keller. The composition of malt-extract, according to Culbreth,[2] is as follows:

	Per Cent.
Water..........................	20 to 25
Maltose........................	48 to 70
Dextrin........................	2 to 16
Diastase.......................	1 to 2
Protein........................	8
Phosphoric acid................	0.3 to 0.4
Lactic acid....................	0.75 to 1.50
Ash............................	1.5

Keller modified this by neutralizing the malt-extract with potassium carbonate. Caloric value, 80 per ounce.[3]

Another preparation of malt-sugar is to be found in dextrimaltose (Mead, Johnson & Co.). This consists of maltose, 51 per cent.; dextrin, 47 per cent.; sodium chlorid,

[1] Not in bulletin, but added to complete table.

[2] Materia Medica and Pharmacology, 1906, 91.

[3] A powdered form of malt extract is prepared by Borcherdt & Co., Chicago.

2 per cent., and has a food value of about 110 calories per ounce. It is wholly soluble and contains no cellulose, protein, or fat.

Malt-extract is more laxative than are other malt-sugar preparations. Seel[1] ascribes this property to the presence of diastase.

There is also a preparation on the market known as Dextrimaltose No. 3, which is a preparation in powdered form of a malt extract neutralized with potassium carbonate. It only differs in composition from the dextrimaltose by its potassium carbonate content. In the experience of the writer the dextrimaltose preparations have seemed to vary in their laxative qualities in about the following relation, the least laxative being given first and the most last: Dextrimaltose, No. 1; Horlick's food; Mellin's food; Dextrimaltose No. 3; Borcherdt's dry malt soup extract, and the liquid malt soups.

It should be mentioned here that these preparations show signs of irritation in the gastro-intestinal canal, such as formation of gas and regurgitation of food in direct proportion to their laxative qualities.

Marriott[2] has suggested as a food of value, especially in cases of decomposition, a mixture of 45 volumes of corn syrup with 55 volumes of water. This gives about a 50 per cent. carbohydrate. The carbohydrate in this mixture consists of approximately 55 per cent. dextrin, 30 per cent. maltose and 15 per cent. glucose.

Wheat flour is used in the form of flour-ball, which is prepared by rolling 4 cups of flour in a piece of cheese-

[1] Zeitschr. f. Kinderheilk., 1911 (Ref.), i, 471.

[2] Jour. Am. Med. Assoc., 1919, lxiii, 1173.

cloth, tying tightly, and boiling for six hours, then dry. The cloth and outside crust are then peeled off, the chalky center broken into small pieces, and dried in an oven two to four hours. This is then ground up and sifted until it is very fine. The flour thus made is a very good carbohydrate food for infants, and used in much the same way as barley flour or oatmeal.

Ruhräh[1] advises the more extensive use of the *Soja bean* in infant feeding. He has prepared a flour of the following composition:

	Per cent.
Protein (N × 6.25)	44.64
Fat	19.43
Mineral matter	4.20
Moisture	5.26
Crude fiber	2.35
Cane-sugar	9.34
Non-nitrogenous extract	14.78
Starch	None.
Reducing sugars	None.

Caloric value is 120 to the ounce.

Gruels made from this flour settle on standing, to prevent which it is well to add barley, oat, or wheat flour gruel before cooking.

A *vegetable soup* which can be used as a diluent is made in the following way: A small handful of spinach, a large beet, and two medium-sized carrots are chopped fine, and boiled slowly for two hours in a quart of water, strained, and the evaporation loss made up. This corresponds to the vegetable soups advised by French writers.[2]

[1] Jour. Amer. Med. Assoc., 1910, liv, 1664.

[2] Pehu, L'Alimentation des Enfants Malades, Paris, 1908, 64.

The carrot soup advised by Moro[1] is made by boiling 500 gm. (1 pound) of carrots in 200 c.c. (½ pint) of water, and then add enough salted meat (beef) soup to make 1 liter (quart).

Courtney, Fales and Bartlett[2] recommend that vegetables be prepared by steaming rather than by boiling since in the process of boiling a large proportion of the mineral content of vegetables is lost. Spinach is the best vegetable to provide a salt addition to the diet.

PROPRIETARY FOODS

There is no question that, in spite of the efforts of eminent pediatricians to decry them, the proprietary infant foods have been the mainstay of the general practitioners. The elaborate means which their manufacturers have employed to exploit their virtues and instruct in their use may be regarded as largely responsible for this. So long as such foods are used by the physician with definite indications and with definite ends in view, and so long as their composition is definitely known; and, again, provided they are to be used in connection with milk, then we may say that their chief dangers are eliminated. But what is done is so decidedly opposite to this that the whole system is to be condemned.

In a great many cases it is much more simple to advise the use of a proprietary food in much the same way that we advise the use of flour, oatmeal, or barley. When so used and so understood the proprietary food resumes its natural position, that of an adjuvant in the preparation of food for the infant.

[1] Münch. med. Wochenschr., 1908, lv, 1637.

[2] Am. Jour. Dis. Child., 1917, xiv, 34.

The following table has been compiled from many sources, and, of course, gives only approximate values, but it will probably prove ample for the use of anyone who cares to use such foods in his practice:

	Biedert's ramogen	Biedert's somatose	Biedert's butter-milk conserve	Biedert's food	Mellen's food	Eskay's food	Horlick's malted milk	Horlick's food	Ridge's food	Imperial granum	Lacto-preparata	Carnick's food	Nestle's food
Protein	7.0	9.0	9.5	11.5	11.5	6.0	16.5	12.5	12.0	14.0	14.5	10.3	14.3
Fat	16.5	16.5	0.6	4.5	0.2	1.0	9.0	1.7	1.0	1.0	12.5	7.5	5.5
Sugar	34.5	34.5	30.0	51.4	80.0	68.0	68.0	80.0	2.0	2.0	64.0	27.0	58.9
Starch	.....	.....	4.5	28.4	.....	21.0	.....	.....	76.0	73.5	.....	37.4	15.4
Salts	1.5	1.5	2.0	1.7	3.6	1.3	3.9	2.5	0.5	0.4	3.7	4.5	3.8
Caloric value to ounce	100.0	100.0	93.0	133.0	120.0	128.0	135.0	125.0	121.0	120.0	140.0	120.0	116.0

Mayerhofer and Pribram[1] have preserved human milk with hydrogen peroxid and dried to a powder.

[1] Zeitschr. f. Kinderheilk., 1911, iii, 525.

OLIVE OIL AND COD-LIVER OIL

Of the fatty foods other than milk, olive oil and cod-liver oil are most frequently used.

Olive oil is about 70 per cent. olein and is a pure vegetable oil, with no alkaloids with any physiologic action. It has been advised in constipation, but is of very doubtful value; in fact, is in most cases distinctly harmful when so used.

Cod-liver oil is much used in pediatrics, principally in combination with phosphorus, in the treatment of rickets. It is a food rather than a drug, and should be so considered. It consists of 70 per cent. olein and 25 per cent. palmitin, with but little stearin, cholesterol 0.5 to 1.5 per cent., and iodin content .001 to .002 per cent.; the alkaloids, trimethylamin, asellin, and morrhuin are present in small quantities; traces of chlorin, bromin, phosphorus, and sulphur to the amount of 0.3 per cent. Aside from its action on rickets, cod-liver oil, in certain chosen cases, seems to distinctly increase the resistance of the infant to respiratory infections.

OTHER FOODS RICH IN PROTEIN

Of the foods rich in protein other than cows' milk protein, albumin-water, eggs, beef-juice, and such protein compounds as nutrose, somatose, etc., may be mentioned.

Albumin-water is made by adding the white of one egg to a pint of sterile water; this can be warmed slightly and given with or without the addition of salt. Its use has not been so widespread recently.

Beef-juice can be made in either of two ways: A round steak may be very slightly broiled and the juice squeezed

out, or a pound of finely ground steak may be placed in a pint of sterile water and kept on the ice over night. In the morning the whole is strained through a sterile cheese-cloth bag, and the liquid, seasoned and slightly warmed, gives an excellent beef-juice.

Mention should be made of beef-extract. This contains little more than stimulating extracts, all nourishment having been removed in the process of making. Hence the use of the extract is not to be advised in infant feeding.

Nutrose and somatose deserve only to be mentioned. Nutrose[1] has the following composition: Albumin, 65.2 per cent.; nitrogen-free substance, 20.15 per cent.; water, 10.5 per cent.; ash, 4.15 per cent. Somatose[2] is a water soluble derivation of meat-albumin.

SALTS

As yet no attempt to reduce the amount of salts in the food has been made in infant feeding, except in the use of albumin-milk (see later). It has, however, been a common custom to add alkalis, such as *lime-water* or *sodium bicarbonate*, to the food to render it more like woman's milk.

Clark[3] has shown that addition of alkalis does not bring about the desired result, and may be distinctly harmful. Bosworth and Bowditch[4] have shown that the addition of lime water to milk results in precipitation of calcium phosphate and citric acid. The soluble CaO is markedly

[1] Lengesken, Handb. Neu. Arzneimittel, Frankfort-on-Main, 1907, 419.

[2] *Ibid.*, 561.

[3] Jour. Med. Res., 1915, xxvi, 431.

[4] Jour. Biol. Chem., 1917, xxviii, 431.

reduced. The precipitate shows calcium caseinate and calcium phosphate. This addition of lime water may reduce the soluble calcium and phosphorus below that of human milk. *Sodium citrate* has been added with the idea of softening the casein curd. Whether necessary or not, it has apparently attained its end in many cases. *Sodium chlorid* is usually added in the preparation of barley-water. In view of our recent knowledge of the influence of sodium chlorid on the body temperature, especially in infants suffering with severe nutritional disturbances, it would seem advisable to omit it when the barley-water is prepared for such cases.

FRUITS

It has long been recognized that orange juice was a distinct and frequently favorable addition to the usual food of infants. It has usually been given with the idea, first, that it was distinctly anti-scorbutic in its action, and, second, that it was laxative. It is pretty generally recognized that the first action is well established but it is very doubtful whether it is wise to add orange juice to the diet as indiscriminately as is sometimes advised. In the experience of the writer such additions have not always been without the production of gastro-intestinal symptoms, such as regurgitation, gas formation, etc. As to the second, Gerstenberger and Champion[1] have recently shown that orange juice may be distinctly constipating in its action.

Pease and Rose[2] have championed the use of the banana in feeding young children, especially if it be baked or eaten raw when fully ripe. According to them the banana

[1] Am. Jour. Dis. Child., 1919, xviii, 88.
[2] Am. Jour. Dis. Child., 1917, xiv, 379.

should not be eaten raw until the brown spots begin to appear on the skin.

NUTS

Chapin[1] has recently prepared a "milk from almonds." This is made by triturating sweet almonds in water; 100 grams were added to 200 grams of water. This was then squeezed out and diluted to 300 grams. The composition is as follows: fat 5.19 to 7.02 per cent.; protein 3.3 to 4.4 per cent.; carbohydrates 0.86 to 1.21 per cent.; ash 0.36 to 0.55 per cent.; water 86.74 to 90.5 per cent.

KOUMISS AND MATZOON

Other foods occasionally used in infant feeding are koumiss and matzoon. The composition of koumiss is as follows:[2]

	Ten analyses, König	From mares' milk, W. Fleischman	From cows' milk, W. Fleischman	Forty-eight household, J. A. Wanklyn
Water..........	87.88	91.53	88.93	87.32
Milk-sugar.	3.76	1.25	3.11	6.60
Lactic acid.	1.06	1.01	0.79	
Casein..........	2.83	1.91	2.03	2.84
Milk-fat........	0.94	1.27	0.85	0.68
Alcohol.........	1.59	1.85	2.65	1.00
CO_2............	0.88	0.88	1.03	0.90
Ash............	1.07	0.29	0.44	0.66

Koumiss is not used except by those who have a special regard for it. It has never attained general use as an infant food.

[1] Arch. Ped., 1919, xxxvi, 28.

[2] Blythe, Foods and Their Composition, London, 1909.

Of matzoon, the same may be said. Its composition is as follows:[1]

Protein	3.48
Fat	3.49
Milk-sugar	3.68
Lactic acid	0.90
Alcohol and other products of fermentation	0.13
Mineral salts	0.69
Water	87.63
	100.00

Peiser[2] advises the use of kephir in the treatment of ambulatory cases.

Composition of Kephir[3]

Nitrogenous substances		3.49
Casein	2.53	
Albumin	0.36	
Acid albumin	0.21	
Hemialbumin	0.21	
Peptone	0.039	
Fat		1.44
Lactose		2.41
Lactic acid		1.02
Alcohol		0.75
Ash		0.68
Water		90.21

[1] Holt, Diseases of Infants and Children, New York and London, 1907, 160.

[2] Monatsschr. f. Kinderheilk., 1912, xi (Orig.), 175.

[3] Leach, Food Inspection and Analysis, New York, 1913, 159.

Fig. 9.—Utensils necessary for home modification of food for infants.

CHAPTER XI

ARTIFICIAL FEEDING FOR THE NORMAL INFANT

GENERAL INSTRUCTIONS

In preparing food for the normal infant certain *utensils* are necessary. Most of these should be of graniteware, since this is more easily and thoroughly cleansed. A large pan for mixing, which will hold about 2 quarts, and a spoon for stirring are absolutely necessary. A funnel, which is small enough so that it can be inserted into the bottle, is desirable. Double-boilers and large kettles are useful in the preparation of such things as barley-water. For the cleansing of bottles a bottle-brush must be used. A glass graduate should be used for measuring fluids.

Bottles and Nipples.—In choosing a bottle, not only the bottle itself but the nipple must be taken into consideration. The chief object to be obtained is the reduction of the chances of infection to a minimum. In order to do this the rubber of the nipple should be the best possible, so that it will not crack, and the amount of rubber surface coming in contact with the food preparation should be the least convenient. In the opinion of the writer the danger of infecting the milk lies not so much in the bottle as in the nipple.

If the nipple be cracked, even with the most careful cleansing it becomes impossible to remove all the milk-clots, and though the nipple be boiled, these clots may form a hard coagulum about a central nidus of bacteria,

which eventually may be responsible for infection of the food. In the bottle the transparency of the material and the smoothness of the surface renders it possible to see and remove any such infective material. For these reasons it is well to choose a bottle the shoulder to which begins at the neck and slopes straightly and directly toward the body. This gives a bottle the inside of which can be readily cleansed with a bottle-brush and whose neck is fitted to receive the ordinary rubber nursing-nipple. The base of the bottle should set squarely on a plane surface, and the neck be sufficiently small so that one will have little difficulty in adjusting the nipple. It is interesting to note here that Phelps and Stevenson[1] have found antimony in sufficient quantities in nipples to be a source of real danger.

In *cleansing the bottle* it should first be rinsed with cold, and then hot water. The bottle is then cleansed thoroughly with soapsuds and the bottle-brush, after which it is rinsed and boiled in water for five to twenty minutes. The outside is dried and a sterile cotton-plug closes the neck.

The nipples are turned inside out and a stiff brush used for the mechanical cleansing. After boiling, they are kept in a saturated solution of boric acid until time for use.

In *preparing food* for an infant it is best to make up the total amount for twenty-four hours. If water is to be used as a diluent, it should first be sterilized and then cooled. Barley-water, oatmeal-water, etc., can be made up in sufficient quantity to last two to three days if kept in a cool place. It is always well to dissolve the carbohydrate in water before adding the milk. If this be starch, it is usually necessary to boil for one-half to several hours.

[1] U. S. Hyg. Lab. Bull. No. 96, 55.

Fig. 10.—Bottles and nipples: *a*, The best style bottle for general use; *b*, this bottle has too narrow a neck and also a shoulder, which makes it difficult to clean; *c*, this bottle is all right, but the nipple is too large and cracks easily; it is also very expensive; *d*, it is impossible to clean this bottle well; *e*, the worst type of bottle and nipple; *f*, brush for cleaning bottle.

If malt-extract is used, it is well to bring to a boil to destroy any enzymes which may be present. Sugars and infant foods can be dissolved in cold or only warm water.

As to whether the milk should be pasteurized or sterilized, will depend upon the source of the supply and the method of handling, which in each case must be passed upon by the physician in charge. Milk should never be added to a warm diluent, whether this be plain water or a carbohydrate solution, but the latter should be cold before the milk is mixed with it.

After the milk and diluent are thoroughly mixed, the prescribed quantity should be placed in each sterile bottle, this sealed with a sterile cotton-plug or paper-cap, and placed on ice or in a cold place until ready for use.

When ready for use the nipple is placed on the bottle, in which process it is well to have the bottle sitting on a plane surface, firmly grasped between the palms of the hands, the fingers being used to adjust the rubber over the neck. The bottle is then warmed (except where albumin-milk is used) until a drop of the fluid on the back of the hand feels distinctly warm (not hot).

During the time the child is taking the bottle this should be held in the hand of the attendant and adjusted at a proper angle, so that air will not be given with the food. No child should consume longer than twenty minutes in taking a bottle. In many hospitals it is the custom to elevate the bottle on a pillow and allow the child to get the food in the best way it can. This is certainly to be deplored, and the excuse that the attendants are too few should never be accepted. All milk left in the bottle should be thrown away.

DISCUSSION OF STANDARDS

Heubner and Rubner have shown that a normal breast-fed infant requires about 100 calories of food to the kilo weight (45 calories to the pound) in twenty-four hours.[1] It was never the intention of the investigators to give the impression that 100 calories of *any food-stuff under any condition* is the sole requisite in the proper nutrition of the infant. Everyone will readily recognize that the infant organism requires more than simple fuel, so that we must regard this standard rather as a check upon the *amount* of food than as any definite effort to regulate the nutrition of the infant as a whole. Though this standard is not without exceptions, even in the normal infant, it at least gives an idea of the amount of food to be given, and hence furnishes a principle in the nutrition of the *normal* infant.

During the war Pirquet evolved a system of infant feeding based upon a nourishment unit the nem (1 gm. of milk which will free 667 small calories by its oxidation in the human body) and the "sitting height." All foods are reduced in their value to the milk unit (nem) and calculated accordingly. The bases for estimating the food requirements by this method are altogether new and the reasoning by which they were arrived at very complicated. The system represents a revolutionary procedure in calculating infants' diet and probably will not be generally accepted for some time, if at all, unless it proves much more simple

[1] Engel and Samelson (Zeitschr. f. Kinderheilk., 1913, viii, 425) have recently found that the energy quotient for breast-fed children varies between 100 and 120, while that in artificially nourished children is somewhat lower. Zanetti (La Pediatria, 1916, xxiv, 331) found it to be between 80 and 110 for breast-fed babies with an average of 100.

and easily applied than seems possible on superficial examination.

It is doubtless true that in the present state of our knowledge it is impossible to lay down exact formulæ which will suffice in even the majority of normal infants. There may, however, be given certain guides which will tend to direct the groping physician in the way he should go, and still more definite ideas of pathologic conditions will show him when he has passed from the field of the normal into that of the abnormal.

GUIDES TO ARTIFICIAL FEEDING IN THE NORMAL INFANT

In discussing this subject, it will be best to present ideas on nourishment for the infant from the third to the ninth month, and then later to take up the more difficult problem of the first three months of life.

One of the most important points of infant feeding, and especially in artificial feeding, is the *length of the interval between nursings.* When we consider that cows' milk mixtures do not leave the stomach for at least three hours after ingestion, and that the stomach needs a rest after its work, it seems very plausible that a four-hour interval between nursings should bring good results. This is, in fact, the case. It is never advisable to feed the *normal* infant oftener than every four hours. The best hours for feeding are 6 and 10 A. M., 2 and 6 P. M., and 12 midnight. I am assured that no one who systematically and persistently tries this regular four-hour interval during the day, with one feeding at night, will ever be persuaded to shorten the interval. When the infant has reached the age of eight or nine months, the midnight feeding may be given at 10 P. M., thus allowing

the child an uninterrupted sleep of eight hours. To many, the possibility of such a thing is ridiculous, but with the large majority of babies, nevertheless, this can be readily accomplished. No one should expect to take a child who has been on a two- or three-hour interval and abruptly place it on a four-hour one without some difficulty. This difficulty will be greater the older the infant, but with proper firmness even a radical change of this sort can, in the second or third month of life, be accomplished with excellent results within a week, provided the milk mixture is suitable for the case.

One cannot lay too much stress upon the advisability of so regulating the child's life, and especially its nourishment, that it expects certain things at certain times. This not only systematizes the action of the gastro-intestinal tract, but also has a most beneficial effect upon the nervous system.

The *amount to be given at each feeding* must be determined largely by the age of the infant. It has been the custom of the writer to give slightly more than the supposed capacity of the stomach in each bottle. One might expect that this would frequently be accompanied by regurgitation, but such is not the case if the long interval is strictly observed. Undoubtedly, a large amount of the fluid-content of the milk passes the pylorus in a very few minutes, which probably accounts for the fact that no distention or regurgitation results from the feeding of such large quantities. Therefore, in a child three months old, 5 ounces would be given; in one six months, 7 ounces; in one nine months, 8 to 9 ounces. Between these ages the amounts can be readily calculated. To estimate the total amount of food

for twenty-four hours one simply multiplies the amount of each feeding by 5, since that is the number of bottles given between the ages of three and nine months.

We come now to the determination of the food values to be given to the baby in twenty-four hours. While the caloric standard of 45 calories of food to the pound weight in twenty-four hours does not serve as an absolute criterion, it at least points to the amount which when exceeded is likely to cause difficulty. So we may say that though one cannot say absolutely that 45 calories of food should be given to the pound weight in twenty-four hours, he can at least say that in the vast majority of cases not more than this amount should be given. As the child becomes older the food needed seems to decrease in amount, so that from the sixth to the ninth month it is well not to exceed 40 calories to the pound weight.

The most important subject is the composition of the food. If this is taken up as to the amount of each constituent, and then the whole correlated, we will probably best grasp the subject. We must first understand, however, that each constituent is necessary for proper nutrition of the infant, and that it is the combination and not the single constituent which brings about good or bad results.

Allen[1] has very conclusively shown that in twenty-four hours it requires the amount of protein contained in 1 ounce of milk to the pound weight of the child to maintain (theoretically) a nitrogen equilibrium, and that in order that the infant may build up sufficient nitrogen in his tissues the protein of about 1½ ounces of milk to the pound weight is needed. By using the latter amount there is, then, not

[1] Archiv Ped., 1907, xxiv, 899.

only enough food nitrogen to cover tissue-waste, but enough also to supply the growth of the organism. I have found that the clinical results conform very closely to these theoretic calculations, and have had excellent results by using the amount of protein advised by Allen. If we consider the protein alone, however, I am strongly convinced that much more than this amount can be given without in any way disturbing the infant's nutrition, but I do not feel that in the normal child there is any advantage to be gained by so doing.

A much more difficult problem to solve is that relating to the amount of milk-fat to be used. No one questions the fact that in nearly all cases fat cannot be permanently removed from the food without causing grave disorders. On the other hand, such large quantities of fat as have been used in the cream mixtures, so popular in this country, have an effect anything but beneficial on the infant organism. If we are forced to choose between no fat and high fat, our choice must clearly always fall on the latter, but, happily, there is no obstacle to a middle course in this instance. The energy-producing units in the food are to be found largely in the fats and carbohydrates, so the problem to be solved here is rather what shall be the relative amount of fat as compared to the carbohydrates. Any decrease in fat, in other words, must be supplied by the carbohydrates. The fat contained in 1½ ounces of whole (4 per cent.) milk to the pound weight is sufficient to cover the fat need of the infant organism, and in most cases is well taken care of.

It has usually been taken for granted that the carbohydrate best suited for the infant is milk-sugar. There has

PLATE III

Normal stool of child fed on milk (smear showing salve-like consistency).

been a general tendency to give this in excess. Of the three sugars (milk-sugar, cane-sugar, and malt-sugar-dextrin), most babies will consume larger amounts of the malt-sugar-dextrin than of either of the others without nutritional disorder. Certainly the normal infant will receive enough milk-sugar, if this is confined in amount and given in the form of milk-sugar-content of the amount of milk required to supply the protein and fat. The rest of the carbohydrate is best given in the form of maltose-dextrin mixtures and starches, such as barley, oat-meal, flour-ball, etc. Young infants even as early as the third month, will digest appreciable quantities of starch perfectly, and later this constitutes a very important ingredient of the diet.

As to whether or not these mixtures contain a sufficient quantity of salts would be comparatively easy to calculate since milk contains .14 gm. of CaO per 100 c.c. This would mean that the child per pound weight would receive in these formulæ .07 gm. of CaO. According to the calculations already quoted from Holt, Courtney and Fales, the minimum quantity of CaO to be given to an infant would be about .06 gm. and an ample quantity about .08 gm. When we take into consideration that the dextrin maltose mixtures contain about .06 per cent. calcium we see that the calcium in these mixtures would be well above the minimum and would very closely approach the optimum. We have not taken into account the minute quantity of calcium which is to be found in all water, but this would probably not be sufficient to materially influence the results.

The next important inorganic constituent is phosphorus. So far there has been no definite determination of the

quantity of phosphorus required by infants, but if we add 50 per cent. to the quantity for adults we find that the amount of P_2O_5 present in these milk mixtures far exceeds the quantity obtained by this estimation.

There remains yet to be discussed iron. Iron is present in such small quantities in breast milk that it is not given in many of the tables. This means that the child must come into the world with a quantity of iron stored in the body and it is commonly believed that this is true. Cow's milk contains a definite amount of iron, about .001 gm. per 100 c.c., but with the addition of cereals to the food the quantity of iron is materially increased. We may therefore say that with formulæ, such as advised, artificially fed infants would be at least as well prepared to produce hemoglobin as would the breast-fed infant.

One more question remains to be discussed as to the fitness of these formulæ for infants, and that is the question as to whether such formulæ contain vitamines. The best article on this subject as it pertains to infants has already been referred to (Hess, Jour. Am. Med. Assoc., 1921, lxxvi, 693). It should be understood that so far as we know vitamines are not elaborated by animals but are taken in with the food. The first requisite then for milk is that the cow should be fed green fodder. If the cow be properly fed and the milk be sufficiently fresh, there can be little question but that both the fat soluble *A*, water soluble *B*, and the anti-scorbutic properties of the milk will be well preserved and in sufficient quantity to meet the needs of the infant.

At the present time there is no scientific or practical reason for the addition of such alkalis as sodium bicarbo-

nate or lime-water to the food, and their use may be dispensed with without in any way lowering the food value of the milk mixture.

Summary.—If we now sum up the above conclusions, it is seen that the writer believes in simple dilution of whole milk with the addition of carbohydrates, preferably in the form of malt-sugar and various starches, in feeding a normal infant between the ages of three and nine months. These children should never be fed oftener than every four hours during the day and once at night, in the young children the night bottle being given at midnight, and in the older ones at 10 P. M. The amount to be given at each feeding should slightly exceed the stomach capacity for a child of a given age.

Example.—Baby A, six months old, weighing 14 pounds. Stomach capacity at six months of age is 6 ounces; therefore, give 7 ounces at each feeding; five feedings of 7 ounces each equals 35 ounces; 1½ ounces of milk to the pound weight are 21 ounces. Malted food,[1] 1 ounce added.

Final Formula

Milk (whole)	21 ounces—441 calories
Water	14 ounces
Malt food	1 ounce —120 calories
Five feedings of 7 ounces each	561 calories; or,
	40 calories per pound

Baby B, three months old, weighing 11 pounds. Stomach capacity at three months of age is 4½ ounces; therefore, give 5 ounces at each feeding; five feedings of 5 ounces each equal 25 ounces; 1½ ounces of milk to the pound weight are 16½ ounces. Malted food, 1 ounce added.

[1] When malted food is mentioned any of the combinations of dextrin and maltose mentioned on p. 182 may be used.

Final Formula

Milk........................	16½ ounces	—346 calories.
Water.......................	8½ ounces	
Malt food...................	1 ounce	—120 calories.
Five feedings of 5 ounces each		466 calories; or, 42 calories per pound.

Further illustration of these simple principles is unnecessary. As to the amount of carbohydrate to be added, one can only say that this will vary with different babies. With the normal child it is rarely necessary to begin with less than ½ ounce in twenty-four hours. It is better, however, to begin low and work up than to give too much at the beginning. It should be distinctly understood that no set of formulæ yet devised will suit every infant, nor is it likely that such a degree of perfection will ever be reached when we consider that even Nature's efforts in some cases are futile, but from the above rules we can develop formulæ which in most cases will bring excellent results. If the rules are to be followed, they must be followed *in toto*, and not taken singly and applied. The interdependence of such suggestions as the large single feeding and the long interval is obvious. It will be seen, too, that little attention is paid to the dilution of the milk in the examples above given. The writer has purposely chosen for these rather heavy infants. The dilution in most cases would be greater, though the subject, from the standpoint of clinical result, aside from all scientific objection, is of relatively little importance.

The foregoing remarks have applied solely to nourishment between the ages of three and nine months. Before three months of age the artificial feeding of the infant is difficult, and the more difficult the younger the infant.

PLATE IV

Normal stool of child fed artificially on a malt-sugar mixture (partially smeared).

The tolerance for food other than breast-milk is smaller the younger the infant, thus the problem is a difficult one. Again, it is extremely hard to judge of the effect of a given food at the time, because the results may take several days or even weeks before manifesting themselves. Thus, for instance, though a newborn infant may take condensed milk without apparent injurious effect, yet it may, and usually does, so lower the vitality that the slightest infection may prove fatal, or after a few weeks a marantic state may develop from which it is almost impossible to save the infant. With such formidable difficulties confronting us, certainly conservatism is demanded, and though many infants may live and thrive on an ample diet, the physician who systematically confines this during the first two weeks of life will meet with more uniform success.

In the first twenty-four hours the infant should receive nothing but water (sweetened with saccharin).[1] It is well to give this to the amount of 1 to 2 ounces every four hours.

During the *remainder of the first week* it is best to give the food every four hours throughout the day and night, water, to the amount of 1 to 2 ounces (sweetened with saccharin), being given between feedings. It is well to offer these infants 3 ounces of a mixture of half-milk and half-water with a teaspoonful of malt food to each feeding. As a rule, the infant at first takes only 1½ to 2 ounces, but soon gets to the point where it takes the whole amount.[2]

At the beginning of the *second week* the amount of malt

[1] In the young infant it is never necessary to sweeten the water, but the mother or attendant usually insists on it. Do not use sugar.

[2] Benfey (Jahrb. f. Kinderheilk., 1912, lxxv, 280) has had excellent success in feeding the newborn infant with albumen-milk, and the writer can corroborate his statement.

food may be increased from day to day, depending upon the reaction of the infant. If it shows a tendency to colic and the formation of gas, the sugar should be reduced in quantity. Proceeding in this careful manner, we soon arrive at a formula with which the child is satisfied and on which it gains weight normally.

Between the second and the third month it is not, as a rule, necessary to change the dilution of the milk, but the amount given at each feeding and the carbohydrate may be gradually increased. Some time in the second month, usually when making the change from 3½ to 4 ounces at each feeding, one of the night feedings is discontinued and the single night bottle given at 12 midnight. Toward the end of the second month the amount at each feeding can be increased to 4 or even 4½ ounces. One can usually at this time slightly strengthen the dilution by increasing the milk and reducing the water.

Examples

Baby X, seven days old ,weight 10 pounds.

Milk............	9 ounces	Six feedings of 3 ounces each.
Water...........	9 ounces	
Malt food.......	½ ounce	

Baby Y, fourteen days old, weight 8 pounds.

Milk............	9 ounces	Six feedings of 3 ounces each.
Water...........	9 ounces	
Malt food........	¾ ounce	

Baby Z, two months old, weight 10 pounds.

Milk............	12 ounces	Five feedings of 4½ ounces each.
Water...........	10½ ounces	
Malt food......	1 ounce	

With the use of such a formula, one can scarcely expect to have the child gain normally in weight, but one, in large measure, can avoid nutritional disturbances which are of

such a grave nature when they affect the infant under three months of age.

After the *ninth month*, in sharp contrast to the early weeks of life, it is no difficult task to nourish artificially the normal infant. The tolerance for food, both as to quantity and quality, is much greater. The general indication is to tend to reduce the amount of milk and increase the carbohydrates.[1] At nine months the amount to be given at each feeding reaches 8 to 9 ounces; the milk (given in quantity according to weight, 1¼ to 1⅓ ounces to the pound) is now diluted with a rather thick starch gruel, consisting of ½ to 1 ounce of barley flour, oatmeal, or flour-ball to 1 pint of water. After the *tenth month* a vegetable soup (see Chapter X), to which has been added a certain amount of starch food, may be given. This, combined with milk and malt food, makes a very palatable mixture, and is oftentimes of great value at this time. It is well now to discontinue the 10 P. M. bottle, thus limiting the feedings to four—6 and 10 A. M. and 2 and 6 P. M.

Before we pass on to the question of feeding in the second year, there are several points in regard to feeding the infant in the first year which should be discussed. It is the custom of the author in the preparation of the infant's diet, in the majority of cases, to order the food mixture to be boiled for five minutes. He believes that the advantages to be gained in this way far over-ride the disadvantages and agrees with the published results of Lane-Claypon.

For many years it has been the custom to give fruit

[1] The relation of these to rickets will be discussed subsequently; at present suffice it to say that this food is advised without fear of favoring development of rachitis.

juices, especially orange juice, as a regular article of diet to young infants. While employing this quite frequently the writer does not advise that it be done in a routine way. The disadvantages of such a proceeding are, first, a slight digestive disturbance may be produced, and, second, that it gives the infant a taste for this food which may be developed to the point of craving with the result that other foods are refused. It has also been the custom and has been advised that cod liver oil be given regularly to breast fed as well as artificially fed infants. This is not without danger even though cod liver oil be given in small quantities since very frequently the giving of cod liver oil is followed by vomiting and loose stools. It should be especially avoided in hot weather. A far more dangerous procedure is the giving of side dishes to young infants. It has become the custom in this country, following the advice of our German colleagues, to give dishes of cereal to infants as young as three or four months. This food is given without taking into consideration that it represents the addition of a large amount of food of high caloric value; that it is not readily digested in young infants, and that the food thus given is especially subject to fermentation with resulting dyspepsia. It is doubtless true that many infants thrive on such foods but it is also true that a large number develop rather serious nutritional disorders which could readily be avoided if more conservative ways of feeding were observed.

Though the giving of vegetables is not so frequent nor is it indulged in at such an early age, it, too, is often followed by rather disturbing results. Sufficient quantities of cereal and vegetables may be added to the milk and when

used in this manner may always be taken into account in measuring the amount desired. In the eyes of the writer there is no advantage in giving these side dishes and there is in many instances rather serious danger.

Nourishment During the Second Year.—It should be a rule never to allow a child to drink more than a quart of milk in twenty-four hours. In many cases this amount is too much, but in no case is it necessary to give more. About this time or a little later it is possible to wean the child from the bottle, but this may be continued until eighteen months or more if desired. Children can gradually be accustomed to cereal gruels and graham crackers, and good arrow-root crackers can be munched after the bottle. In the second year such things as orange-juice, prune-juice, or apple-sauce may form a general article of diet. After the fifteenth month such vegetables as spinach, beets, and carrots, chopped fine and pressed through a colander, can be given, and are usually relished. After eighteen months, small portions of finely divided chicken or beef-steak can be added. I have purposely omitted eggs from this dietary because in many cases they have seemed to me to be distinctly injurious but an egg may be given in place of meat once or twice a week. The diet for the second year of life consists, in the beginning, of milk, cereals, and fruit juices; at fifteen months, vegetables are added; at eighteen months, chicken, lamb, baked fish or rare beef. Up to fifteen months four meals a day should be given. After this, three is sufficient. One should avoid feeding of any sort between meals.

CHAPTER XII

GENERAL CONSIDERATION OF NUTRITIONAL DISTURBANCES OF THE ARTIFICIALLY FED INFANT

Are the nutritional disturbances of the artificially fed infant due to indigestion, faulty absorption, or disturbed metabolism, or to all three? This is the question which confronts the student of infantile dietetics. There can be no doubt but that in certain cases indigestion does play a part. By indigestion is not meant non-digestion, but disturbances of the digestive function through the action of the food or its derivatives. In most cases, for instance, vomiting can be directly traced to an irritation of the gastric mucosa by the food ingested. It is certain, however, that the other two factors are of more general importance for the consideration of our subject. From the chapter on Absorption and Metabolism one will see that most foods are split up into absorbable products by the juices of the gastro-intestinal canal of the infant. That in many instances these products do not perform their work, must be due either to a faulty absorption or a disturbed metabolism, or both. In the marantic child, even though the food is sufficient in quantity to produce a gain in weight and no signs of indigestion are apparent, still the infant often fails to gain and frequently even loses. This can hardly be accounted for except by a deficiency in the absorption or in the metabolic processes. It is necessary, therefore, to look upon nutritional disturbances not as disturbances of the gastro-in-

testinal canal, but as conditions which affect the whole organism in one of the most vital of its functions. The gastro-intestinal symptoms, then, form only a part, though an important part, of the clinical picture, and a diarrhea becomes only a symptom and not a disease. This broader conception necessitates the use of broader terms and more extensive and minute clinical observations, and makes possible a more definite differentiation of clinical entities.

Diseases in general are usually classified in one of three ways: etiologically, pathologically, or clinically. In nutritional disturbances the pathologic condition is so distinctly a chemical one, and the anatomic structures are so little changed, that the pathologic method of classification can be left out of consideration.

The first systematic attempt to classify etiologically the disturbances of nutrition was that of Czerny and Keller. They divided the clinical pictures into two main groups, those occurring from the food-stuffs (*ex alimentatione*) and those from infections (*ex infectione*). In the first group they include disturbance due to fat (Milchnährschaden), that due to starch (Mehlnährschaden), that due to sugar (Zuckernährschaden), and that due to gelatin (Leimnährschaden). Of the last, only one case has been observed, and no further notice will be taken of it than to state that a baby taking a large amount of gelatin in the food developed, without any other distinct symptoms, a bloody diarrhea, which ceased on the reduction of the gelatin in the food. So far as the writer knows, no similar observation has been reported. In the opinion of Czerny and Keller the protein is not responsible for nutritional disturbances of any kind. In spite of the oft-repeated assertion that the protein is the

cause of many of the nutritional disorders encountered in infancy, the writer, in his experience, has never encountered a case where any such position was permissible, nor has he

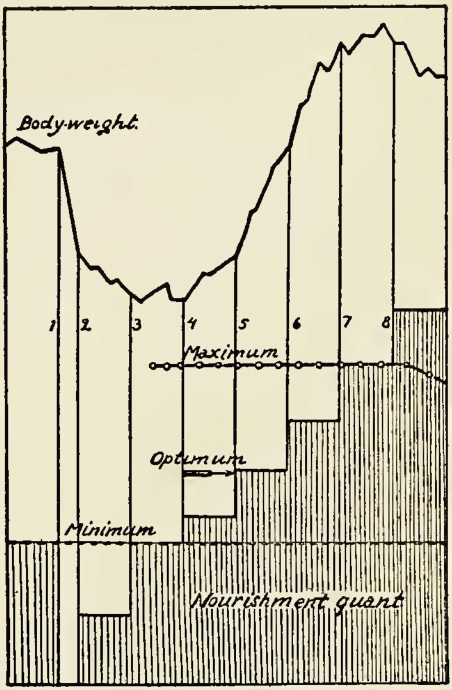


Fig. 11.—In this figure the nourishment quantity at first is at the minimum, and the body weight remains stationary. Food is then taken away entirely, and then for some time remains below the minimum, the body weight falls, but the tolerance increases. With the increase in food the weight increases until the maximum is passed, when the tolerance is lowered and there is a loss of weight. In this figure the optimum represents the quantity of food on which the child shows the best gain, with no tendency to intolerance, while the maximum represents the quantity of food beyond which one cannot go without producing a nutritional disturbance.

been able to find in the literature anything more definite than assertions that colic and constipation were due to an

excess of protein in the food. He is well aware that the large bean-shaped masses in the stool have been regarded by many as casein-curds, and he is convinced of the correctness of this statement. These curds have been seen by him

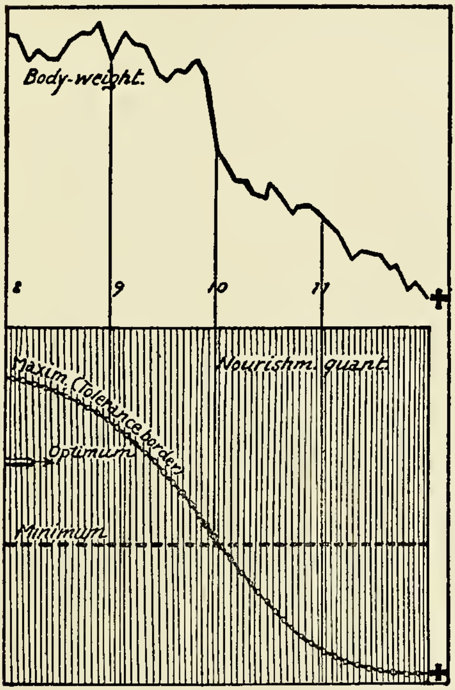


Fig. 12.—This figure shows the effect on the tolerance of continued overfeeding. Throughout the food is above the maximum, and with the continuance of the nourishment the tolerance is rapidly reduced until it is lastingly far below the minimum, and death results.

in stools which otherwise were perfectly digested, homogeneous, and of normal color, so that he does not see how their presence can be interpreted as anything more severe than a non-digestion, a condition far removed from indigestion. In other words, he looks upon these casein masses as non-

irritating bodies, acting in much the same way as would a foreign body of similar size and consistency.[1]

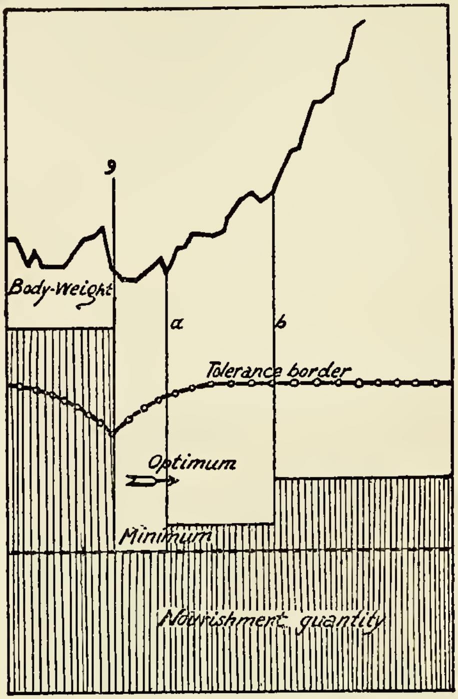


FIG. 13.—In this figure we see the effect on the tolerance of too much food. If the same quantity had been given over a longer period, as in Fig. 12, the result would have been the same, but in this case, the error being recognized soon enough, it is only necessary to reduce the food to the minimum for a short time in order to increase the tolerance, and then, by gradually increasing but at the same time keeping well below the maximum (tolerance border) and up to the optimum, the increase of weight is obtained. One must remember that a given case at a given time has a certain tolerance for a certain food, which tolerance it cannot exceed; but, on the other hand, by raising the quantity of that food above this maximum, the tolerance may be temporarily or permanently lowered.

The "Protein intoxication" of Holt and his co-workers[2]

[1] See Chapter XVII.

[2] Am. Jour. Dis. Child., 1913, v, 268.

is not as yet proven clinically, and the presence of the sodium salts in the food in large quantities rendered the interpretation of the results doubtful. Hoobler[1] in one case noted a condition of stupor which gradually dis-

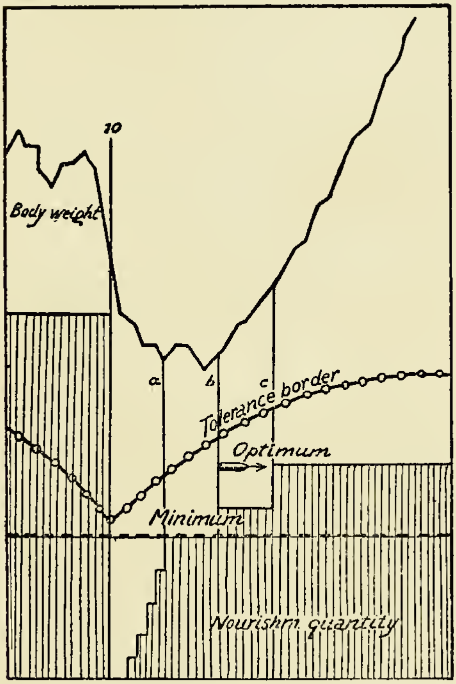


FIG. 14.—This figure shows a more advanced condition than that of Fig. 13. In this, in order to raise the tolerance, it is necessary to reduce the food far below the minimum and then increase gradually.

appeared with reduction of protein in the food, and Benjamin[2] thinks that a long continued high protein diet may alter the chemical composition of the body.

There can be no question of the value of an etiologic

[1] Am. Jour. Dis. Child., 1915, x, 153.

[2] Zeitschr. f. Kinderheilk., 1914, x, 185.

diagnosis. In fact, to treat properly a given condition, such diagnosis is absolutely necessary, but to the average physician the case presents a certain clinical picture which must first be differentiated from other clinical pictures,

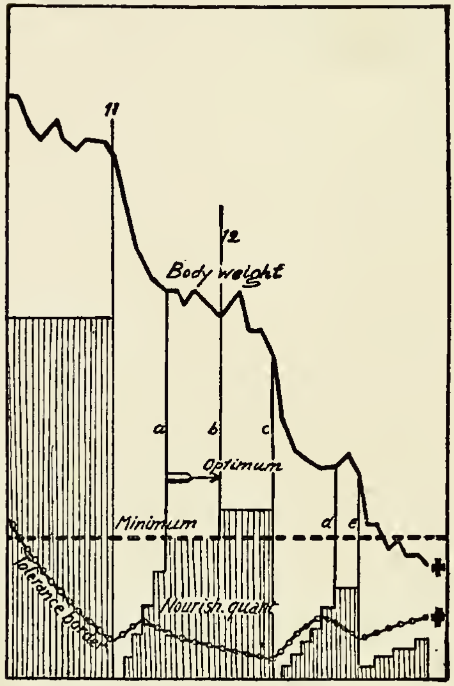


Fig. 15.—In this figure the food has remained so long and so far above the tolerance border that all efforts to increase this by reduction of the food fail, and the child dies, the tolerance border continuously remaining below the minimum.

and then, if possible, the cause of the disturbance must be determined.

Many long and involved classifications of the nutritional disturbances of the infant have been attempted, most of which have been so complicated as only to confuse, or so

indefinite as to render it impossible to distinguish the one clinical picture from the other. The classification suggested by Finkelstein has two advantages, it is simple and at the

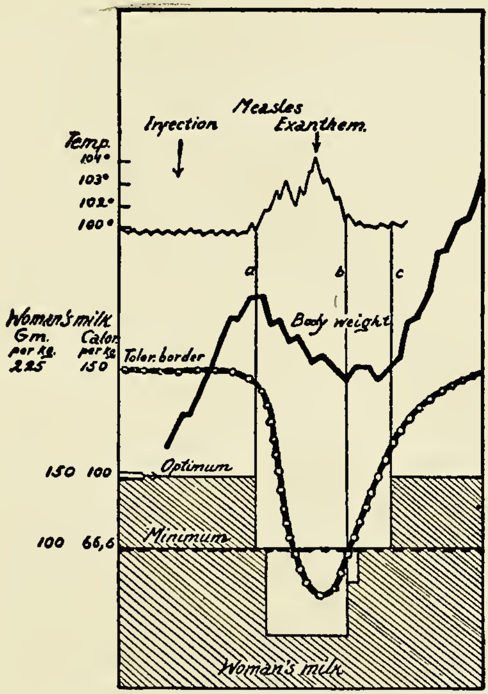


Fig. 16.—This shows very well the effect of an acute general disease on the tolerance. Many of the gastro-intestinal symptoms given as a part of the clinical picture of general diseases can be readily cured by simple reductions of the food. If during these acute stages the same amount of food is given as during health, the tolerance is widely overreached, and sometimes grave consequences ensue. It is a fortunate provision of nature that under such circumstances infants voluntarily reduce the amount of the food which they will take, and this often contrary to the wishes of their attendants.

same time it covers the whole field. He distinguishes four general clinical pictures: (1) Weight disturbance; (2) dyspepsia; (3) decomposition; (4) intoxication. When

one has learned the symptoms of each of these, he is surprised to find how readily the given case will be classified under one of these four heads. He may not agree with Finkelstein as to the causation of the clinical picture in

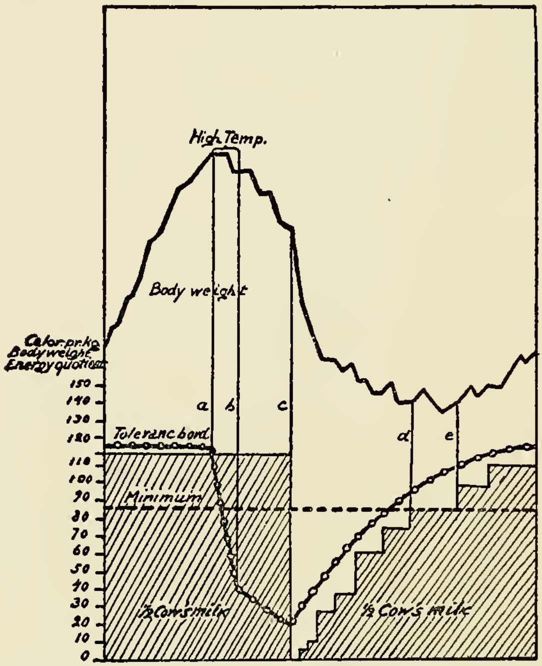


FIG. 17.—This shows graphically the effects of heat on the tolerance, and the raising of the tolerance by reducing the food quantity.

question, but he must admit that his case can be readily classified under one or more of these heads. This is the general classification which will be followed in this treatise.

Before discussing the various nutritional disturbances, let us consider their general characteristics. This can best be done by following closely the charts prepared by

von Pirquet.[1] He regards as the chief factor the tolerance of the child for a given food at a given time, and portrays

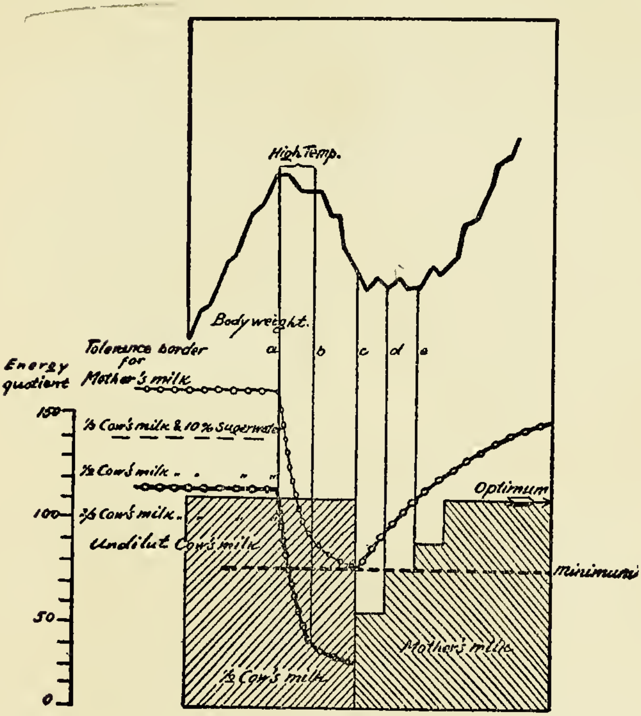


FIG. 18.—This figure is most instructive in demonstrating the value of mothers' milk. We see shown here the difference in tolerance not only between cows' and mothers' milk, but also between different dilutions of cows' milk. If we remember that this is purely schematic, we may prepare for ourselves several such charts showing in different children the different tolerance for different foods. The tolerance for breast-milk is, almost without exception, greater than that for other milks. Whereas in a severe case the tolerance for cows' milk may be well below the minimum, that for breast-milk may be at or above this.

the ways in which that tolerance can be reduced. It is apparent to all that if the food is insufficient to prevent

[1] Zeitschr. f. Kinderheilk., 1910, i, 111.

a loss in weight, the infant cannot long survive such treatment. If the tolerance of the infant for a given food be below the minimum required to maintain body weight, then that food must be replaced by another, or some means must be found to otherwise raise the tolerance.

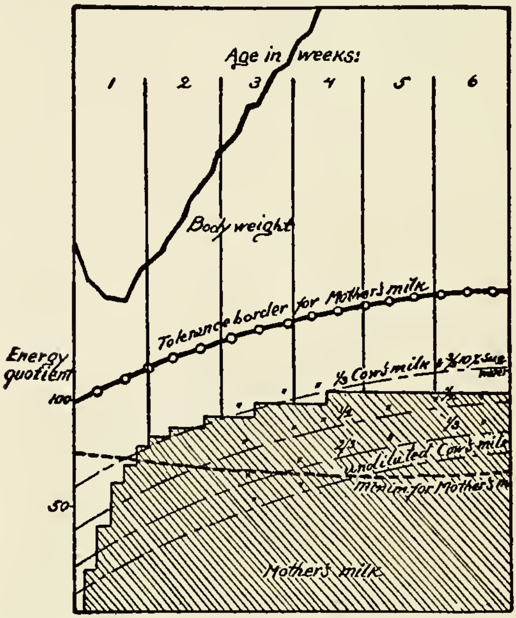


FIG. 19.—This figure again shows the greater tolerance for human milk, but shows, in addition, the beneficial effect which mother's milk has on the tolerance for other food in the newborn infant. This is most instructive and portrays very plainly our experience that artificial feeding in the newborn infant is an exceedingly difficult proposition.

Two or three ideas predominate in all these charts. In the first place, it is plainly seen that if the food in any case is pushed beyond a certain point (which must be determined in each case, but which in the normal child is about 40 to 50 calories to the pound weight in twenty-four hours)

the result in a lowering of the tolerance for all foods, but especially for that particular food. In the next place, it is seen that if the food is sufficiently reduced the tolerance is raised. The necessary amount of the reduction depends upon the severity of the case; in the severer cases the food

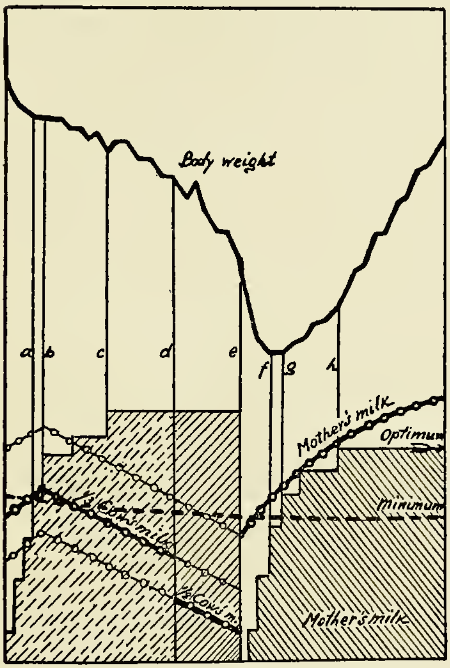


FIG. 20.—This figure explains why artificial feeding in the newborn infant is so difficult, and the effect of mother's milk in producing a recovery.

must be discontinued entirely for a short period. The degree of tolerance regained by reduction of the food quantity depends upon the severity of the case and the length of time the disturbance has existed, but more upon the latter than the former. And lastly, it is shown how the tolerance

for woman's milk is greater than that for any other food. The effect of intercurrent diseases and of heat in reducing the tolerance must agree with the experience of all.

von Pirquet, in ten charts, has given us the essence of infant feeding, containing a bird's-eye view of the whole subject and the general indications for treatment. If one follows the more specific data in the ensuing pages, he will be struck by the exactness of these charts.

CHAPTER XIII

WEIGHT DISTURBANCE[1]

(*Synonyms.*—Fat Constipation; Milchnährschaden.)

Definition.—Disturbance of nutrition in the infant, caused by a *relatively* high fat-content in the food, and clinically characterized by constipation, stationary weight, increased ammonia output in the urine, pallor, fretfulness, and disturbed sleep.

Etiology.—The condition is most frequent among the *better classes* and in the *winter months.* This coincidence might suggest that if the bacterial content of the food is low there is less danger of decomposition, and as a result the more severe forms of nutritional disturbance do not occur. The same class of cases in the poorer classes and in the summer months usually develops a dyspeptic diarrhea. *Artificially fed* infants are almost exclusively affected. Many of these children show distinct signs of *exudative diathesis.* Whether the symptoms of this condition are more prominent because of the fat-content of the food, or the condition itself predisposes to a reduction of the tolerance for fat, is a question, but in those cases where, in spite of a low fat-content in the food, the symptoms of exudative diathesis and weight disturbance appear at the same time, there is reason to think that the cause of the trouble lies in the infant's intolerance for fat, even in moderate quantities.

[1] This conception of weight disturbance differs materially from that of Finkelstein.

This condition was first named "Milchnährschaden" because it was first noticed in those cases to which large quantities of milk were given. The *fat* is the constituent of the milk at fault. This does not mean that the amount of fat in the food necessarily must be large, but that the amount of fat in the food is above the tolerance of the infant for milk-fat. Olive oil and cod-liver oil do not seem to possess the same degree of intolerance for most children, but even these may cause the condition. After this condition is once developed, the fat of woman's milk is not so well borne as before. Too much stress cannot be laid on the point that it is the relative amount of fat and not the actual amount which is to be taken into consideration.

Pathogenesis.—The condition is perhaps produced in the following manner: the fats passing into the intestinal canal are split into the fatty acids; to neutralize these acids there is excreted through the intestinal wall an abnormal amount of alkalis which, combining with the fatty acids, form insoluble soaps. The withdrawal of the alkalis from the system disturbs the acid-alkali equilibrium, creating a relative excess of acids, or, in other words, the formation of an acidosis, as evidenced by the excess of ammonia in the urine. The condition, in contradistinction to the true acidosis, as seen, for example, in diabetes mellitus, is known as relative acidosis. Usuki thinks that this condition may be due to absorption of too large an amount of fatty acids. According to Niemann,[1] a typical soap stool is not necessarily accompanied by increase in calcium in the stool.

Bessau[2] describes the condition as due to the predomi-

[1] Jahrb. f. Kinderheilk., 1912, lxxvii, 533.

[2] Jahrb. f. Kinderheilk., 1920, xcii, 14.

nance of putrefactive processes in the intestinal canal. He[1] found the colon bacillus high up in the duodenum.

Much has already been written in the chapter on absorption concerning the soap stool which forms such an important portion of the clinical picture in this condition. As stated, Aviragnet and Dorlencourt[2] have shown that the calcium soaps are found only after the alkali soaps have been formed. And Bosworth, Bowditch and Giblin[3] state that the elimination of calcium soap in the stools increases directly in proportion to the degree of solubility of the calcium present in the food.

Holt, Courtney and Fales[4] found that in the average normal and constipated stools high soap content is found when the intake of calcium is high, but that constipated stools which contained more soap than normal stools have a lower calcium content. It is therefore possible that the calcium soap stool is a direct result of putrefactive processes in the bowel and the ammonia excretion in the urine may be due to the releasing of a large amount of ammonia either by putrefactive processes or by the formation of calcium soaps releasing ammonia.

Symptoms.—The infant is usually presented for examination because of two symptoms—fretfulness and constipation. The history is that the food has had a high fat-content, and up to a varying period previous to examination the baby has not only gained normally, but far in excess of the normal. After a longer or shorter period the child

[1] Jahrb. f. Kinderheilk., 1919, lxxxix, 213.
[2] Le Nourisson, 1919, vii, 283.
[3] Am. Jour. Dis. Child., 1918, xv, 397.
[4] Am. Jour. Dis. Child., 1920, xix, 97, 201.

became fretful, the stools became hard and dry, and the urine had a bad odor; sleep became broken and restless. On examination you find a fat, flabby child, with pale skin. There may be some intertrigo and even marked eczema.

Gastro-intestinal Symptoms.—Eructations of gas are quite common. Vomiting may or may not be present, but rarely is severe. It is usually confined to regurgitation of small quantities of milk, which may or may not be curdled, or else with the eructation of gas some food is ejected. The most marked symptom is the constipation. The stool is hard and dry and of a white or gray color, closely resembling the ordinary dog stool; the odor is offensive. This stool, when perfectly typical, can be shaken from the diaper without leaving a stain on the cloth. Not infrequently there is seen a small blood-coagulum clinging to the side of the fecal mass, the result of the erosion of the rectal wall by the hard-formed feces.

This stool is typical only of the fully developed case. In the early stages one may be warned of the approaching condition by the appearance of hard, white, sand-like particles, in greater or lesser numbers, imbedded in a fecal mass, which otherwise is homogeneous. Or later, when the condition borders on a dyspepsia, the stool may be greenish, with some mucus, with the same particles usually in larger masses. The typical stool consists largely of insoluble soaps. The reaction is alkaline. The white color is the result of the changes of bilirubin into colorless urobilinogen. The dryness is due to the absorption of water by the large intestine and rectum and to the insoluble soaps. If this condition cxists for some time, a constipation very stub-

PLATE V

Stool showing particles of calcium soap embedded in mass of feces (soap curds).

PLATE VI.

Hard calcium soap stool of weight disturbance.

born in character develops, which is due not only to the hard feces, but to the inertia of the intestinal musculature.

A very distressing symptom in the later stages is the tendency to the formation of gas in the intestines, with resulting distention. This is probably caused by the circulatory disturbance in the intestines as a result of the withdrawal of the alkalis from the intestinal capillaries, and by the mechanically irritating action of the hard fecal masses.

Weight-curve.—In many cases this is quite characteristic. At first, when the child is fed food rich in fat, the gain is rapid and marked, perhaps from ½ to ¾ pound a week. This condition continues for perhaps one to two weeks in the typical case. At the end of this time the weight becomes stationary, and any attempt to produce an increase in weight by increasing the amount of food either produces a dyspepsia or an intoxication, or is followed by a decrease in weight, usually slight in extent. A standstill in weight usually follows the constipation. In some cases the stationary weight is not preceded by a previous gain, but continues with the constipation. The length of time during which the weight remains at a standstill differs with the severity and duration of the disturbance. If the constipation has existed for some time and has been of severe degree, notwithstanding the most approved and careful treatment, it may take two or three months to produce an increase in weight, with cessation of the other symptoms. On the other hand, frequently, a few days will suffice to attain the desired results.

Skin and Tissue Turgor.—These infants are distinctly pale, but one must guard against judging as to the condition of the skin from the color of the cheeks. The symp-

toms of exudative diathesis are especially frequent, and as a consequence the reddened cheek is often seen. This redness is not the rosy blush of the healthy infant's skin, but the sharply outlined dusky or bright red area of a beginning eczema. The pallor of these children is not to be confused with the cachectic pallor of the severe anemia or the bluish pallor of the cyanotic marantic infant. It is due to the congestion of the internal organs, as a result of which the skin capillaries are contracted. The pallor quickly disappears with the institution of proper treatment and the disappearance of the other symptoms. Eczema and seborrhea of the scalp are of frequent occurrence. Intertrigo in the inguinal folds frequently occurs from "scalding" by the strongly ammoniacal urine.

These children are frequently fat, but the tissue turgor is distinctly reduced, and the flabbiness of the child is often noticed even by the mother. The fat of the cheeks, as would be expected, usually retains its normal consistency. The *peripheral lymph-glands* are often enlarged.

Urine.—The chief characteristic of the urine is the high ammonia-content. This is usually detected by the mother, who speaks of the odor as "strong." The increased ammonia is an indication of acidosis, probably a relative acidosis, as mentioned above. The indican reaction is usually quite distinct. No albumin or sugar is found. The urine is highly irritating and causes excoriation of the surrounding parts. This increased ammonia in the urine is not readily detected in the beginning or light cases, but it is quite constant in the more severe.

Temperature.—The excursions of temperature are usually within normal limits or, at most, only a fraction of a degree

either way. Any rise in temperature marks the beginning of a more severe nutritional disturbance or an intercurrent infection.

Nervous Symptoms.—These are usually very annoying. The infants are very peevish and cross, though apparently without pain. The sleep is disturbed and restless, the child wakes at the slightest noise, and frequently sleeps but a few hours in twenty-four. Convulsions, etc., are rather frequent complications.[1]

Diagnosis.—In the well-developed case the diagnosis, based on the constipation, the history of the sudden gain in weight, which then becomes stationary, the high ammonia content of the urine, the pallor and the fretfulness, coupled with a history of large fat-content in the food, is easy. There is no other condition with which it could be confused. Where the weight disturbance is complicated by an intercurrent infection, such as an otitis media or nasopharyngitis, the rise in temperature may cause one to think of an intoxication with constipation. The general aspect of the child, the absence of sugar in the urine, the absence of deep breathing, no collapse, all speak for a weight disturbance, even though the temperature be raised several degrees.

The chief difficulty lies in the tendency to regard this condition as intimately connected with large amounts of fat in the food. Though this is frequently the case, the condition depends not so much upon the quantity of fat in the food, as the inability of the infant organism to utilize that fat without suffering from a nutritional disturbance.

[1] See Spasmophilic Diathesis.

Prognosis.—This uncomplicated nutritional disturbance, if properly treated, offers a very favorable prognosis as to life. The chief danger lies in the complications. The duration of the constipation varies within wide boundaries. In one case, apparently severe, the change of food will produce remarkable results within a week; in others, of seemingly the same severity, it will take months of the most careful attention to bring the infant back to normal. In the average case at least two to three weeks pass before the constipation is overcome and the weight again assumes its upward curve.

Complications.—Among the common complications are the infections of the nasopharynx, lungs, and middle ear. One characteristic of these infants is their decidedly lowered resistance, as a consequence of which the infections of the respiratory tract are quite common. Another common complication is facial eczema, often with seborrhea of the scalp. All these complications are symptoms of the exudative diathesis, so that it is not surprising that they are so frequently found in weight disturbance.

Sequelæ.—Weight disturbance is often the forerunner of more serious nutritional disorders, such as dyspepsia, decomposition, and intoxication. A very common result of the existence of this severe constipation over a long period is a failure of the intestinal musculature to respond to ordinary stimuli, thereby giving rise to a chronic atonic condition of the bowel, which is very hard to overcome. Contrary to the general idea, rickets is very frequently encountered.

Treatment.—The general indication for treatment is apparent. It consists in the reduction of the amount of

fat in the food and replacing this by some other food-stuff. In this place the carbohydrates offer the only satisfactory substitute. For the purpose of infant feeding, the carbohydrates may be divided into three groups: (1) Milk and cane-sugar, (2) malt-sugar and preparations containing malt-sugar, and (3) the starches. In no case is it well to try to supply all the deficiency caused by removal of the fat with one of these foods. It is better, in general, to use all three, so that the proportions of no one of them will be preponderant.

Dietetic Treatment.—We must first consider the fat. No one will question that some fat in any food mixture to be given infants is highly desirable. It is, therefore, necessary to weigh all points and determine, if possible, the severity of the case. In the most severe cases it is useless to delay in removing all fat (as far as possible) from the food; in other words, to substitute skimmed milk for the whole milk or cream. When it is necessary to do this, a trial of the fat tolerance should, as soon as possible, be made by substituting 1 to 2 ounces[1] of whole milk for the same amount of skimmed milk. If it is found that the infant can take care of this properly, the fat is gradually increased, substituting 1 or 2 ounces of whole milk for the same amount of skimmed milk every other day. If the stools begin to show chalky masses in them (or even white sandy particles) the fat should be again reduced to the former amount. In the milder cases the simple reduction in the amount of whole milk and the addition of carbohydrates is all that is required.

[1] All amounts mentioned refer to the twenty-four hour period and not to the single feeding.

The one *carbohydrate* which seems to give the most satisfaction in these cases is the *malt-sugar.* In giving the carbohydrate, and especially the sugar, progress should be slow, in order to guard against a dyspepsia. Usually it is best to start with about ½ ounce of malt extract in twenty-four hours. This can be increased cautiously, 1 dram at a time, to 1 ounce or even 1½ ounces, rarely more. A small amount of malt food, amounting in all to ¼ to ½ ounce, is added after a few days of the malt-extract. Instead of using plain water as a diluent, barley-water is substituted. In other words, the food consists of about 1½ ounces of skimmed milk to the pound weight in twenty-four hours, which is diluted with barley-water or oatmeal-water to the required amount. At the beginning malt-extract is added, which is slowly increased, and then malt-food. In determining whether the required amount of malt-food has been added, we must depend upon the consistency of the stool. Very frequently in the beginning stages of the treatment the stool is not passed without effort, and often not without help, but when passed formed, it should be of a brownish color and salve-like consistency. For some reason malt-extract is much more active for overcoming the constipation than is malt-food, so that though in the milder cases a food containing malt-food may produce the wished-for result, in the severer cases malt-extract is necessary. It is frequently of advantage, when increasing the fat, to raise the amount of the carbohydrates at the same time. This tends to keep the stool soft and to prevent the return of the other symptoms. In doing this, however, we must bear in mind two things: The amount of fat cannot be thus raised indefinitely, for the tolerance border is soon reached, and, on the

Fig. 21.—Method of insertion of glycerin suppository.

other hand, an excessive increase of the carbohydrates will lead to a state of dyspepsia.

Hygienic Treatment.—Pure, fresh air is even more desirable in these infants than in the well baby, because of the marked predisposition to respiratory infections. The skin, too, should be kept clean, especially in the folds, and the diapers should be changed as soon as they are wet or soiled. Great care should be taken to avoid contact with infectious disease of any sort.

Medicinal Treatment.—Any attempt to overcome a constipation of this nature by the use of drugs is to be condemned. The relief of the constipation is, at best, temporary, and the cathartic leaves the bowel more inert than before. After a proper diet has been prescribed, if the bowels do not move satisfactorily, suppositories should be introduced at regular intervals, in order, if possible, to stimulate the peristalsis by irritating the rectal sphincter. I have never found a cathartic which could be regularly administered in these cases without eventually leaving them worse than before its use. Sometimes orange-juice or the syrup from stewed prunes will render excellent service. Even in young infants petroleum oil in doses of two to three teaspoonfuls twice a day may be effective.

Symptomatic treatment will be taken up later in Chapter XVII.

CHAPTER XIV

DYSPEPSIA

(*Synonyms.*—Fatty Diarrhea; Zuckernährschaden; Duodenal Indigestion.)

Definition.—A nutritional disturbance due to overfeeding by one or many of the food constituents, characterized by vomiting, diarrhea, and slight elevation of temperature.

Etiology.—This condition is almost as frequent in breast- as in bottle-fed babies. In this place only the bottle-fed infants will be considered. (For Dyspepsia in Breast-fed Infants see Chapter IX.)

Dyspepsia is more frequently encountered in the *summer* months than in the winter. *Thin, delicate,* especially *marantic* infants are most susceptible, but no children can be regarded as in any way protected against it, provided the error in diet is sufficiently severe. Young infants under three months are more likely to be affected, because at that age the tolerance for food is rather narrowly limited. In the winter months infants living under *poor hygienic surroundings* are more likely to have dyspepsia, while those existing under better circumstances are more inclined to the weight disturbance; this is due, in all likelihood, to the tendency among ignorant people to commit graver dietetic errors, and also, perhaps in part, to contamination of the food given the infant.

The cause of this disturbance is overfeeding, usually not so much of one constituent, as of all constituents, of the food. In older infants these attacks are frequently brought

on by grave errors in diet, such as the giving of cake, bacon, gravy, etc. In the young infants the most frequent cause is an excess of *sugar* (either milk-, cane-, or malt-), and less often of *fat*. One of the chief offences in these young babies is too frequent feeding. This not only irritates the stomach and intestines by keeping them continuously over supplied with work, but it leads the mother to give far more food than the infant can tolerate because the single feeding seems so small.

There is some controversy as to what constituent of the food is directly to blame for this condition. All agree that in certain instances the sugar is at fault. In those cases where the fat-content of the food is high, Finkelstein thinks that the excess of fat causes a lowering of the tolerance for sugar, and in this way the sugar is directly at fault. It is hard to explain all cases in this way, and it is very likely that a high fat-content may be directly irritating to the intestinal canal.

Milk-sugar and *cane-sugar* seem to be most flagrantly to blame, but malt-sugar, either in the form of malt-extract or malt-food, may cause a dyspepsia which, however, is usually of a mild nature. Among the prepared foods none is more active than *condensed milk*, which is frequently responsible for the condition in young infants, and produces, as a rule, a severe type.

Symptoms of a dyspeptic nature may be caused by slight decomposition of the milk. This factor, if continued over some time, may cause a severe disturbance, but if detected early, can be easily remedied by supplying a good milk. It should be noted here that Bahrdt and his co-workers[1] have

[1] Zeitschr. f. Kinderheilk., 1914, xi, 403, 416.

been unable to produce dyspeptic symptoms with decomposed food or with fatty acids introduced into the stomach, and this opinion has recently been substantiated by Bernheim-Karrer.[1] Blum[2] has reported a case of diarrhea evidently due to the use of milk from cows which had been fed on fresh alfalfa hay.

It is not at all uncommon for older infants on the breast to be fed from the table. In many cases this leads to attacks of vomiting and diarrhea. The same may be said of those artificially fed. Another rather frequent cause of dyspeptic attacks is the common custom of giving side dishes, especially of cereals and vegetables to young infants. Attacks of dyspepsia are frequent complications of other than gastro-intestinal diseases, and as such will be considered in the proper place.

Pathogenesis.—Dyspepsia is a disorder of absorption and metabolism, and to some degree primarily of digestion. If the digestive processes are involved, it is usually as a result of the general condition and not as a primary affection. The formation and absorption of acids (formed from the sugar or fat) or the withdrawal of the alkalis from the system, caused by the increased irritation and consequent secretion of the intestinal mucosa, may either or both account for the acidosis, which is shown by the increased ammonia excretion in the urine.

It has been shown (Bahrdt, Edelstein, v. Csonka, Bamberg, Huldschinsky[3]) that the acid which is most frequently present in large amounts in the stools of dyspeptic infants is

[1] Zeitschr. f. Kinderheilk., 1916, xiii, 435.

[2] Arch. Ped., 1913, xxx, 534.

[3] Zeitschr. f. Kinderheilk., 1911, iii, 313, 322, 350, 366.

acetic. Butyric is present in amounts of .06 per cent., while caprillic and formic acids are present in small quantities. An increased peristalsis could be produced by the addition of certain low fatty acids to the food. This was especially true of acetic acid. If these were introduced through a duodenal fistula, the increased peristalsis could be produced with small amounts of acid. The amount of acid, however, which was required to produce these symptoms when added to the food was three to six times as much as can be formed in cows' milk. Huldschinsky[1] found, on examining the stomach contents from 50 infants, that increase in the volatile fatty acids could rarely be found. He thinks that the fluid fatty acids of the stomach can only endanger the organism if the functions of the stomach are already altered.

Greer[2] found that with the subcutaneous injection of the lact-albumin of cow's milk reaction would be obtained much more often in children suffering with dyspepsia, thus suggesting that there might be a greater permeability of the intestinal canal.

Stransky[3] found that *rest*-N of the blood was somewhat increased in dyspepsia. Scheer[4] states that in severe dyspepsia there was likely to be an increase of the bacterial content of the stomach.

Bessau[5] is of the opinion that this condition is the result of fermentation high up in the small intestine. Jundell[6]

[1] Zeitschr. f. Kinderheilk., 1913, v, 475.
[2] Arch. of Ped., 1917, xxxiv, 810.
[3] Monatsschr. f. Kinderheilk., 1920, xix, 10.
[4] Jahrb. f. Kinderheilk., 1920, xcii, 328.
[5] Monatsschr. f. Kinderheilk., 1915, xiii, 431.
[6] Zeitschr. f. Kinderheilk., 1913, viii, 235.

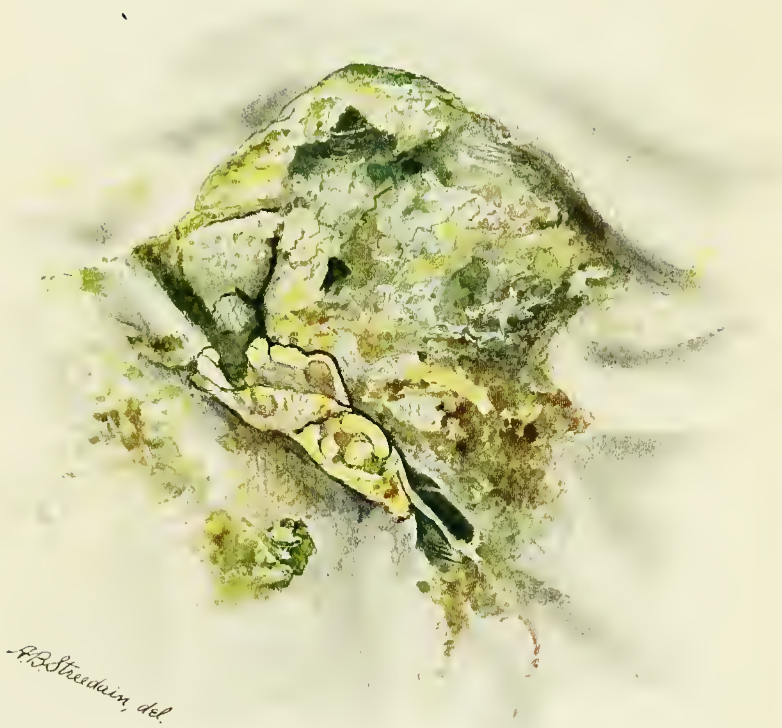
finds evidence of destruction of body tissue in dyspepsia. The nitrogen retention is lowered as is fat absorption, while the dry substance of the feces is increased. The excretion of sodium chlorid, calcium, phosphoric acid, and potassium is increased.

Symptoms.—The essential symptoms of dyspepsia are vomiting and diarrhea, neither of which is severe. In addition, there is a distinct tendency to excessive formation of gas in the alimentary canal with resultant discomfort.

Gastro-intestinal Symptoms.—The *vomiting* is distinctly the result of the stomach irritation. It may come immediately after feeding or at any time between bottles. Vomiting may occur many times, or once, or not at all. The vomitus is usually curdy and of a distinctly acid odor. Frequently accompanying the vomiting there is *eructation of gas;* this is a frequent and very disturbing symptom.

The *stools* are passed from four to six times in twenty-four hours. They are usually green and contain curds and mucus. In those cases most distinctly connected with excess of sugar in the food they are foamy and their passage is accompanied by much flatus. Where the cause of the disturbance is an excess of malt-sugar the stool is usually brown, without mucus or curds, and often distinctly watery and foamy. The "curds" here mentioned are not the large, hard, bean-like casein curds, but small balls of mucus, scraggly masses of undigested fat, or sand-like particles of insoluble fat-soaps. In the so-called fatty diarrhea, an uncommon affection and one which comes under the heading of dyspepsia, the stool is yellow and oily, and a portion placed on a slide spreads out evenly in all directions when

PLATE VII



Infant's stool showing fat curds as scraggly masses. As seen in dyspepsia.

the cover-glass is applied. Under the microscope fat-globules cover the field. Mucus is found in the form of small balls or in strings. Blood is never present. In the chemical examination of diarrheic stools Holt, Courtney and Fales[1] found an increase over normal of the water, protein and Na and K content.

Distention of the abdomen is frequent, due to disturbance of the intestinal blood-supply and the active formation of gas in the bowel. It is not of the same grave character as that due to a condition where the lack of muscular resistance, both in the musculature of the abdominal wall and in the intestines, provides little effort toward the expulsion of the gas. In this condition usually the abdominal walls are strong and peristalsis is active, so that the condition is rather an active than a passive one.

The general trend of the *temperature* is above the normal, rarely reaching 101°F. and often dipping to 98°F. or even lower. On studying the curve, however, it will be seen that the temperature for the whole twenty-four hours is distinctly more above than below the normal mean, and that the daily variations exceed by 1 or 2 degrees those encountered in the normal infant.

The *urine* contains an increased amount of ammonia, but no albumin, sugar, or casts. Indican may be increased in amount, as was shown by Maccone.[2] Though the ammonia-content is high, as a rule, the urine does not excoriate the skin.

The *skin* is pale and the tissue turgor is distinctly reduced. Oftentimes the highly acid stools excoriate the skin about

[1] Am. Jour. Dis. Child., 1915, ix, 213.

[2] Riv. d. clin. Ped., 1919, xvii, 1.

the anus. Very often an existent moist facial eczema will be manifestly improved by an attack of dyspepsia.

During the first days of this condition there is a distinct though usually not marked loss in *weight.* This may amount to as much as ½ pound in forty-eight to seventy-two hours. After that the weight remains stationary or only gradually diminishes. Daily variations may be quite marked, but as long as the dyspeptic condition continues the general trend of the weight-curve is downward.

The infants are not only *restless* and *nervous*, but suffer from distinct pain, due to the accumulation of gas in the intestinal canal. The attacks of pain are similar to those found in the breast-fed child under similar conditions. Sleep is broken and restless. When awake the infant, if not crying and peevish, is never still, but is boring the head into the bed, drawing up its legs, rolling the eyes, and perhaps gnawing its fingers.

Diagnosis.—In the diagnosis of this condition at times peculiar difficulties present themselves. In the first place we must distinguish dyspepsia from parenteral affections, and in the next place the different causative factors must be differentiated.

In general, a parenteral disease which resembles dyspepsia or (perhaps it would be better to say) causes dyspeptic symptoms, differs from this in two main points: The temperature is either elevated or normal, and not the low fever of the dyspepsia, and the nervous system is differently affected.

Not infrequently *congenital syphilis* is accompanied by vomiting and the increase of the number of stools to four to six a day, green, and containing curds and mucus. But in

congenital syphilis the temperature is almost invariably normal or subnormal, the spleen is enlarged, there are eruptions of various kinds on the body, and the child, though cross, is not alert and active. The Wassermann reaction and especially the therapeutic test are of great value.

In *miliary tuberculosis* the only symptom which attracts the mother is often the diarrhea, but in this disease the temperature, though irregular, is well above normal; here, too, a spleen is to be palpated, a cough is often present, and the infant is much more likely to be apathetic than cross and irritable.

Another condition which often shows dyspeptic symptoms is *otitis media.* In this condition the temperature is, as a rule, out of all proportion to the dyspeptic symptoms. Usually the simple expedient of pressing the finger over the external auditory meatus will give a good idea of the seat of pain, which can be confirmed by examination of the tympanic membrane.

A *nasopharyngitis* may prove very puzzling, because one will not know whether he has a case of nasopharyngitis with dyspeptic symptoms or dyspepsia complicated by a nasopharyngitis. From a practical standpoint it is much more profitable to pay attention to the dietetic treatment than to the local treatment, so that it is not of paramount importance to distinguish between the two possibilities.

Of course, dyspeptic symptoms may occur in many other conditions, such as bronchopneumonia, etc. The discussion of these will be deferred to a later chapter.

The only nutritional disturbance with which it is at all likely that dyspepsia will be confused is *intoxication.* The difference is largely one of degree. The serious condition

of the patient, the high temperature, the deep, pauseless breathing, the semicomatose state, the albuminuria and the lactosuria, and the leukocytosis, all speak for an intoxication. As a rule, too, the number of stools in intoxication is much greater than in dyspepsia. An enlargement of the liver in a fat baby suggests intoxication rather than dyspepsia.

After the diagnosis of dyspepsia is made, it becomes necessary to distinguish the cause of the dyspepsia. There are two distinct causes—the sugar and the fat. In the cases of dyspepsia due to overfeeding with sugar the predominant symptom is the formation of gas; this manifests itself in four ways: eructations, distention, colic, and foamy stools.

Where malt-sugar is to blame, the stool is usually brownish, while in those cases where the milk- or can-sugar has caused the dyspepsia, the stools are usually grass-green and contain mucus and fine curds.

Whereas the weight disturbance occurs often with small amounts of fat in the food, dyspepsia, if due to fat at all, can usually be traced to cream mixtures. The symptoms are not greatly different from those of sugar dyspepsia, except that gas formation is not so prominent a symptom. The stool may be that of a fatty diarrhea, *i. e.*, oily and composed almost entirely of fat-globules, or it may be green and contain the chalky curds of the insoluble soaps. A history of preceding fat constipation is not infrequent.

The cases of dyspepsia due to decomposition of the food are not common, because it is rare that an infant would be given milk sour enough to cause this disturbance. The only method of making the diagnosis is by the history. In fact,

there is some question whether acid decomposition in milk is ever sufficient in itself to produce dyspeptic symptoms.

Prognosis.—Dyspepsia in itself is not a fatal condition, but in the first three months of life it very often is the beginning of a state of decomposition (marasmus) which is very baffling from a therapeutic standpoint. If dyspepsia occurs in a bad case of decomposition the outlook is very serious.

Dyspepsia under proper treatment ceases within twenty-four to forty-eight hours, but if not properly cared for, continues, and finally ends in a decomposition, intoxication, or an intercurrent infection.

Complications.—The complications are not many. Nasopharyngeal infections often follow attacks of dyspepsia, and are probably the result of the lowering of the resistance. Excoriation of the skin about the buttocks by the irritation of the stool is sometimes seen. In other diseases, such as pneumonia, dyspepsia is more often secondary than primary.

Sequelæ.—The sequelæ are of much more importance than the complications. The decomposition which so frequently follows a sugar dyspepsia of the early months of life is a most severe condition, and one which requires the greatest resourcefulness to combat. Intoxication is another frequent sequela of dyspepsia. This is often an especially severe form because of the previous depleted state of the infant due to the dyspepsia.

Treatment.—The *dietetic* treatment consists essentially in reduction of the food. In the severest or most prolonged cases it is best to give barley-water sweetened with saccharin (not sugar) for twenty-four hours. Then follow with a skimmed milk and water mixture, starting with

about 1 ounce of skimmed milk to the pound weight in twenty-four hours. The skimmed milk is increased at the rate of 1 to 2 ounces a day until the infant is getting about 1½ ounces of skimmed milk to the pound weight in twenty-four hours. The skimmed milk is then gradually replaced, 1 or 2 ounces at a time, with whole milk, and malt-food is cautiously added and later malt extract to prevent fat constipation. In the less severe cases the general line of treatment is the same, except that the progress is more rapid. The infant at the beginning of the treatment may be given an amount of skimmed milk equal to 1½ ounces to the pound weight in twenty-four-hours, or this initial food may be a whole milk mixture in the dilution of 1 to 3.

In the young infants under three months of age the albumin-milk, if properly given, is most satisfactory. No one should try to give this food unless he has had sufficient experience with it to be able to get a fairly stable mixture. I am persuaded that failures are due largely to the inability of those using this food to prepare it. In dyspepsia, at the beginning of treatment or just after the twenty-four-hour starvation period, the food should be given to the amount of 3 ounces to the pound weight in twenty-four hours. Within 1 or 2 days malt food should be added gradually, beginning with about ¼ ounce in twenty-four hours and increasing to 1 ounce or, at most, 1½ ounces. One should be cautious about giving this food in full amount or in adding the carbohydrates. A careful mother can soon learn to prepare it, and, of course, such modifications as the substitution of skimmed milk for buttermilk can be used, though they are probably not so efficacious.

One must be careful in these cases of dyspepsia in giving

either milk- or cane-sugar, since a small amount of either may be very troublesome. Even though the dyspepsia be apparently of the type due to overfeeding of fat, the sugar must be reduced.

Leichtentritt[1] found that the best results in acute stages were to be obtained with buttermilk whose degree of acidity is at least 50. He thinks this acts by producing an acidity of the stomach which inhibits the growth of bacteria.

Breast-milk is of especial advantage in those children under three months of age. It should never be given except after a starvation period of twenty-four hours, when the dyspeptic symptoms have disappeared. The nursing period should at first be limited to three to five minutes, and then gradually increased. These infants should never be nursed oftener than every four hours. Friedberg and Noeggerath[2] report good results with skimmed breast milk.

When dyspepsia complicates decomposition, one must be very careful not to prolong the starvation period. It is often of advantage not to take away food entirely, but to begin with small amounts and work up slowly. This combination is especially severe and one offering many difficulties in treatment.

To infants one year or over it is well to give buttermilk undiluted and unsweetened, four feedings of 6 or 8 ounces each for the first 24 or 48 hours. Toast may be added on the second or third day and gradually the child is returned to a proper diet. It is well to avoid giving oatmeal or vegetables early unless a tendency to constipation develops.

It is very important that the *hygienic treatment* be taken

[1] Arch. f. Kinderheilk., 1920, lxviii, 195.

[2] Jahrb. f. Kinderheilk., 1921, xciv, 119.

care of. The daily bath should, of course, be given, and the diaper should be changed immediately after urination, but especially after defecation. Fresh air is very important, and the company of individuals having infections of the respiratory tract, even though slight, should be avoided.

In uncomplicated dyspepsia there is no indication for *medicinal treatment.* The use of an initial cathartic is not necessary. If the vomiting becomes severe, stomach-washing, with the administration of a bismuth mixture, may cause relief. The symptoms are, however, the direct result of poor feeding, and the correction of the diet is the all-important thing in the treatment. Clock[1] and Sinclair[2] have reported excellent results, however, by the use of lactic acid bacillus cultures, and I am able to confirm these results, but I do not think the extreme claims of Clock are justified. Aschenheim[3] uses calcium lactate in these cases as an adjuvant to treatment in order, if possible, to produce soap stools. Choay[4] advises the use of tannate of gelatin, 0.25 gm. three to six times a day. The writer has had no experience with this treatment.

[1] Jour. Amer. Med. Assoc., 1913, lxi, 164.

[2] Arch. Ped., 1913, xxx, 529.

[3] Monatsschr. f. Kinderheilk., 1913, xii (Orig.), 229.

[4] Le Nourisson, 1918, vi, 41.

CHAPTER XV

DECOMPOSITION

(*Synonyms.*—Marasmus; Atrophy; Malnutrition.)

Definition.—A chronic state of malnutrition seen in infants, characterized by inability so to assimilate the food given as to gain weight properly; by subnormal temperature, by emaciation, and by a greatly lowered resistance.

Etiology.—To approach this subject in the proper way it is necessary to distinguish cases of this sort dependent on nutritional disturbances from those due to parenteral affections. The latter will be taken up in succeeding chapters; in this we will deal only with decomposition or marasmus due to nutritional disorders.

The gastro-intestinal disturbances which cause decomposition almost always begin before the third month. The earlier in life these disturbances occur, the more likely are they to lead to a chronic state of malnutrition. As a rule, this condition is dependent not upon a single attack of dyspepsia, but upon repetition of these attacks. The preceding disturbances may be dyspepsias or intoxications, or perhaps both; the weight disturbance rarely is followed by a decomposition unless it is extremely severe, or is of that peculiar type designated by Czerny Mehlnährschaden (starch nutritional disturbance).

A high sugar-content of the food seems to be the most frequent history in these cases. In fact, in a large proportion the infant has been fed during the early months of

life on condensed milk. The tendency to decomposition does not seem to be so great where a reasonable amount of fat has been given. It should be noted on the other hand that Nobecourt[1] lays stress upon the inability of these infants to take care of fat as evidenced by the increased residue of this material in the feces and is inclined to look upon the fat as a possible causal agent.

In older children gross errors in diet, continued over some time, with repeated attacks of dyspepsia or intoxication, are usually responsible. Sometimes, however, an ill-managed single attack of intoxication may be followed by a long period of marasmus.

Decomposition is seen in its most advanced forms almost only in the *poorer families* and in orphan asylums; the milder degrees, however, are very frequently seen in more prosperous homes. *Rickets* can hardly be regarded as a contributing factor, for these children rarely show even a moderate form of this disorder. *Poor hygienic surroundings*, with foul air and improper care, probably contribute in large measure to the development of the chronic state of malnutrition. Decomposition is most often seen in the *winter months*, not, in all likelihood, because of any direct influence of cold weather, but because in the summer months similar cases die from acute disturbances.

Pathology.—Anatomic changes are very few and not well marked. In the intestines Helmholz[2] has noted the presence of superficial duodenal ulcers which Gerdine and Helmholz[3] have recently shown are the result of strepto-

[1] Arch. d. Med. d. Enf., 1916, xix, 169.

[2] Arch. Ped., 1909, xxvi, 681.

[3] Am. Jour. Dis. Child., 1915, x, 397.

coccic infection. The same investigator thinks[1] that the intestinal mucosa is less resistant to post-mortem digestion. He found no special changes in Paneth's cells. Schelble,[2] after exhaustive examinations, records the "complete absence of organic changes in the digestive organs recognizable with our present methods." Nor could that investigator, on bacteriologic examination, find any evidence of a bacterial cause of the condition. In the liver and spleen Helmholz was able to demonstrate an increase of iron-pigment. The amount of pigment bore no relation to the severity of the case, but there did exist a certain interrelation between the amount of pigment in the liver and that in the spleen. When the liver contained little or no pigment, the spleen contained large amounts, and *vice versâ*. This increased pigment, however, was not demonstrated by Schelble. Barbier and Cleret[3] found sclerotic and degenerative changes in the liver. Aside from general atrophic changes Nobecourt[4] notes infiltration of the mucosa of the stomach and intestine with leukocytes and hypertrophy of the hypophysis.

Pathogenesis.—The most exhaustive work on the metabolism of decomposition has been carried out by Courtney.[5] She found no disturbance of protein metabolism, but the fat absorption was appreciably and at times markedly diminished as a result of increased peristalsis and a high content of insoluble soap in the feces. The formation of fatty acids, however, did not reach such a degree that the

[1] Jahrb. f. Kinderheilk., 1909, lxx, 458.

[2] Studien bei Ernährungstörungen, Leipzig, 1910.

[3] Arch. d. Med. d. Enf., 1914, xvii, 401.

[4] *Ibid.*, 1916, xix, 234.

[5] Amer. Jour. of Diseases of Child., 1911, i, 321.

ash-content of the intestinal tract was insufficient to neutralize them. There was no distinct tendency to acidosis. Frank and Wolff[1] and Schlossman[2] show that the respiratory quotient corresponds to the body surface and not to the body weight.

These findings would seem to point to a deficiency on the part of the organism to assimilate and use or store up the heat- and energy-producing portions of the food, and thus conserve the body energy which hypothesis is confirmed by the metabolic findings of Bahrdt and Edelstein.[3] Minsk and Sauer[4] have found that the non-protein nitrogen of the blood is increased in decomposition, and that urea nitrogen constitutes about 50 per cent. of this. When the urea nitrogen is low and associated with a low non-protein nitrogen the condition seems to be favorable. Stransky[5] has in part confirmed these findings. The power of assimilation of olive oil seemed to be in some cases much greater than that for milk-fat. It is interesting to note here that Greer[6] has found that in decomposition the subcutaneous injection of the lact-albumin of cow's milk is more frequently followed by positive reaction than in normal infants. Interesting in regard to absorption are the investigations in osmosis by Mayerhofer and Pribram.[7] They found that while osmosis through the intestinal wall of infants dead of acute gastro-intestinal disease was more

[1] Jahrb. f. Kinderheilk., 1913, lxxviii, Erganzungsheft 1.

[2] Zeitschr. f. Kinderheilk., 1912, v, 227.

[3] *Ibid.*, 1914, xii, 15.

[4] Am. Jour. Dis. Child., 1917, xiii, 397.

[5] Monatsschr. f. Kinderheilk., 1920, xix, 10.

[6] Arch. of Ped., 1917, xxxiv, 810.

[7] Wien. klin. Wochenschr., 1909, xxii, 875.

rapid than normal, the osmosis through that of an infant dead of chronic nutritional disturbance was much slower.

It is very likely that there is in decomposition a lowered absorption by the intestinal mucosa, which, however, is purely chemical in nature, and does not manifest any anatomic changes which can account for the degree of impairment of function. Maccone[1] finds that the average per cent. of fatty acids in the stool is only 17.45, and that the parodoxical reaction of Finkelstein is accompanied by an increased proportion of the amount of neutral fats and soaps. Mattill, Mayer and Sauer[2] in their investigations of the glucose tolerance in atrophic infants found that there was a marked increase.

Bessau and Bossert[3] have found an increased bacterial content in the upper portion of the intestinal canal. Bessau[4] thinks that the condition is the result of putrefaction high up in the intestine. In addition, there may be a marked disorder of internal metabolism, which makes it impossible for the organism to utilize even those products which are absorbed. Upon the degree of impairment of these two functions depends the severity of the case. In those cases of decomposition due to starch over-feeding, Hayashi[5] found that in 5 out of 8 cases the fat had altogether disappeared from the liver. In 1 of the others the fat was very much reduced and in 1 there was some fatty degeneration. Stolte,[6] on examination of the liver in these cases,

[1] La Pediatria, 1919, xxvii, 202.

[2] Am. Jour. Dis. Child., 1920, xix, 42.

[3] Jahrb. f. Kinderheilk., 1919, lxxxix, 213.

[4] Monatsschr. f. Kinderheilk., 1915, xiii, 431.

[5] Monatsschr. f. Kinderheilk., 1913, xii (Orig.), 221.

[6] Jahrb. f. Kinderheilk., 1913, lxxviii, 167.

found that the dry substance was reduced and the total ash was increased. Nitrogen, fat, magnesium, sulphur, and phosphorus were practically unchanged. Stolte thinks that in this condition the organism is rich in water.

Utheim[1] has made some exhaustive examinations on atrophic infants. In the first place she found as compared to the normal that there was a low protein percentage in the blood. This was combined with a low rate of blood flow. Marriott[2] used these findings in explaining his very interesting hypothesis on the nature of this condition. He feels that decomposition is essentially a state of starvation continued over a long time so that there is destruction of body tissue due to the efforts of the body to meet the requirements of growth and energy, that reduction in the blood volume is one of the results of this condition and that until it is remedied there is no tendency of the organism to repair.

Symptoms.—In general, these cases are marked by their lack of symptoms rather than by any pronounced group of clinical manifestations. Common to all is the emaciation, the degree of which, as a rule, depends upon the duration of the condition. Some are quite irritable, while others are content to lie all day without any apparent discomfort or distress, all are hungry and eager for food, which cannot be given in quantities sufficiently large to satisfy the apparent demand without endangering life. Vomiting may or may not be present, and there is a tendency rather to constipation than to diarrhea. The temperature is regularly subnormal, often markedly so. In the severest

[1] Am. Jour. Dis. Child., 1920, xx, 366.

[2] Am. Jour. Dis. Child., 1920, xx, 461.


Fig. 22.—Case of decomposition.


Fig. 23.—Case of decomposition.

case the child looks like a diminutive wrinkled old man. Pacchioni[1] thinks that there is also a deficient functional activity of the cells which is hereditary in character.

Skin and Tissue Turgor.—The skin is pale, often a transparent white. Sometimes in advanced cases it takes on a brownish hue. This latter is more frequent in cases of decomposition due to exclusive starch diet (Mehlnährschaden). In the severest cases and just before death, cyanosis gives a grayish hue to the skin; this tint is first noticed about the mouth, but is usually universal. Not infrequently a dry scaling eczema is encountered. This usually occurs on the thorax or face, and is very chronic in its nature. The moist forms of eczema are never seen.

The subcutaneous fat is practically absent over the entire body, except in the milder cases in the cheeks. In many extremely emaciated infants there still remains a small pad of fat in each cheek, although the skin over the rest of the body is in folds and shows no signs of subcutaneous fat. (See Chapter III.)

Temperature.—Characteristic of this condition is a subnormal temperature. By this is meant not that at all times the temperature is below the lower limits of the normal, but that an aggregate of the day's temperature, taken at frequent intervals, will be below the normal taken under the same conditions. In the severest cases and especially during a collapse the temperature (rectal) may go as low as 95°F. or even lower, and in the moderate forms of the condition it is not unusual for the morning reading to be 97°F. for days at a time. A registration of over 99°F.

[1] La Pediatria, 1913, xxi, 728.

is rare, unless caused by some complication. Though the bettering of the condition is usually accompanied by a gradual return to normal temperature, the opposite is rarely true. A lowering of the temperature is not, as a rule, gradual, but results from a sudden collapse, with an accompanying drop of often 2 or 3 degrees in a very few min-

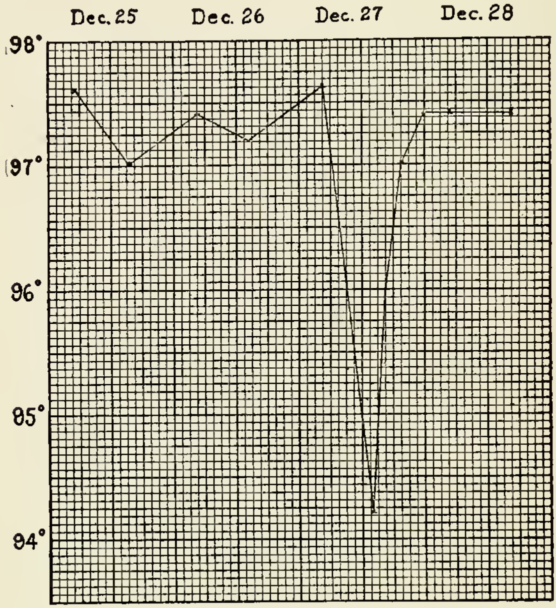


Fig. 24.—The temperature-curve of a case of decomposition, showing the acute fall during a collapse.

utes (Fig. 24). After the collapse, if the child survives, it may take several days for the temperature-curve to return to its former height.

Weight.—Quite characteristic of these cases is a stationary or steadily falling weight. In the milder cases the weight remains at the same level, perhaps showing daily

variations of 1 or 2 ounces for weeks at a time, in spite of the most careful dosage of the food. In the severest cases the child loses weight steadily up to the time of death.

The great problem is to give enough food so that the weight is maintained, and at the same time not so much as to cause gastro-intestinal disturbance. If the food is increased in quantity past the point of tolerance, these infants will react with a fall in weight frequently not accompanied by any gastro-intestinal symptoms whatever. This reaction (the more food the less weight) is called by Finkelstein the *paradoxic reaction,* and is of great importance in determining the tolerance of the child for the particular food mixture given. In the most severe cases the border of tolerance is below that for the amount of food necessary to sustain life. Hence the inevitable result must be death, since if we keep within the boundaries of tolerance the infant must starve; if we exceed this amount, a nutritional disturbance develops which ends fatally. It is hardly necessary to state that here as elsewhere the tolerance for different foods is different, so that whereas an infant might not be able to tolerate even minimal quantities of a whole milk mixture, on the other hand, its tolerance for breast-milk might be well above that amount necessary simply to sustain life.

Marriott's ideas are somewhat at variance with those just expressed. He feels that many of these children will not respond until given a definitely increased amount of food. In fact he advises that in some cases one should give as much as 150 to 200 calories per kilo.

Guidi[1] finds that in this condition where there is marked

[1] Riv. d. clin. Ped., 1916, xiv, 513.

increase of the urea content of the cerebrospinal fluid one may regard the condition as serious. He found that anything over .5 per cent. of urea was greater than normal; and anything over 1 per cent. was alarming.

During a collapse the loss of weight is out of all proportion to the general symptoms, which can only be explained by assuming that some sudden factor has brought about a dissolution of the chemical combinations in which part of the tissues is held (most probably the water and salts), and that as a result these are excreted (the water through the lungs, kidneys, and skin, and the salts through the kidneys and, possibly, the intestinal wall). The loss of weight during a period of collapse may attain 8 to 10 ounces in a very short time.

After a longer or shorter period of reparation the infant begins to increase in weight. This not infrequently occurs, even though the food mixture has remained weeks without change in amount or composition. If during this stage of convalescence no attempt is made to hurry recovery by increasing the food too rapidly, and hence no nutritional disturbance intervenes, it is not unusual to see a steady gain of 8 to 10 ounces a week, continued for many weeks. The stage of reparation is much shorter in the older than in the younger infants, and the final results in both are frequently surprising.

Gastro-intestinal Symptoms.—Symptoms referring to the gastro-intestinal tract are, as a rule, few and unimportant. Hunger is a prominent symptom, and is manifested by gnawing the fingers and hands, and by the frantic eagerness with which these infants take the bottle. Occasionally an increased flow of saliva with drooling is noticed. Eruc-

tation of gas is not commonly seen, nor is vomiting, though at times regurgitation of food may prove troublesome. Abdominal distention is infrequently present. In the milder cases a slight atonic constipation is the rule, while in the severer ones a slight diarrhea (five to six greenish mucous and curdy stools in twenty-four hours) is often seen.

Prolapse of the rectum may occur from the relaxed musculature and the straining from constipation. In the typical cases the stool itself shows little variation from what would be expected of the normal child on like food, except that it is formed. Flesch[1] has confirmed the findings of Helmholz by determining the presence of the duodenal ulcer by finding blood in the stools. He thinks that these ulcers are peptic in type. As suggested by Holt,[2] Hess finds that the duodenal catheter may prove of value in the diagnosis of these cases by showing blood on the tip.

Nervous Symptoms—In the earlier stages the infant is apt to be very cross and irritable. Sleep is disturbed. In hospitals and under proper regulations at the home, however, it soon becomes peaceful and the sleep more profound. Convulsions are not often met with, except the terminal convulsions, which may occur during or at the end of a collapse. Restlessness may cause the hair on the occiput to be rubbed thin or to disappear entirely. There are no symptoms on the part of the *respiratory tract*, except perhaps a terminal pneumonia, which may be shown by the presence of a few crepitating râles posteriorly on either side close to the spinal column.

[1] Jahrb. f. Kinderheilk., 1912, lxxvi, 542.

[2] Amer. Jour. Dis. Child., 1913, vi, 381.

In the *urine* of these atrophics Barbier[1] found the glycuronic acid absent until the stage of convalescence.

Raimondi[2] states that in the period which precedes the return to normal there is always to be found a trace of glycuronic acid, but in the more serious conditions the continued absence of glycuronic acid from the urine is a bad sign.

Maccone[3] has shown a somewhat varied increase in the amount of indican to be found in the urine of these infants which is decreased towards the end stages.

Cutter and Morse[4] found that while the creatinin excretion in their case was not changed, the creatin was absent until the stage of convalescence.

The *pulse* is slow, but not weak The rate is 80 to 100 per minute, which during a collapse may be reduced as low as 60, but even then does not seem weak.

McCullough[5], in electro-cardiograms, in 2 of 16 cases found alterations of the cardiac mechanisms which he thinks are results of alterations in the blood and body tissue. These alterations disappeared after improvement of the nutritional condition.

Bloch[6] has reported more extensively on xerophthalmia in cases of malnutrition resembling at least in their etiology the "mehlnährschaden" of Czerny and which were described in the original description of this condition. Bloch has more intimately associated the condition with the low

[1] Arch. d. Med. d. Enf., 1916, xix, 225.

[2] Le Nourisson, 1918, vi, 104.

[3] Riv. di clin. Ped., 1919, xvii, 1.

[4] Am. Jour. Dis. Child., 1916, xi, 331.

[5] Am. Jour. Dis. Child., 1920, xx, 486.

[6] Jahrb. f. Kinderheilk., 1919, lxxxix, 405.

fat content of the food. It might be mentioned here an analogous condition is encountered in animals who have been fed on a diet deficient in fat soluble A.

Collapse.—This comes on suddenly, with no premonitory symptoms, and frequently without any warning whatever. Sometimes after exposure to cold or heat or as the result of undue excitement, but more often without any assignable cause, the child's skin becomes cold and cyanotic, the face becomes expressionless, the extremities and head hang limp. The pulse slows down and the temperature (rectal) drops to 95° or 96°F. The breathing is labored and often accompanied by a little groan. Sometimes convulsions occur which are clonic in nature and of only slight duration, with no regularity of distribution. This condition may continue for twelve to twenty-four hours, and then the child may gradually recover under careful attention. Unhappily, this results not so frequently as we might wish. More often death supervenes in a few hours.

Diagnosis.—Although apparently so free of symptoms, this condition offers several points which are of great importance in diagnosis. First of these is the *subnormal* temperature. Though other than nutritional disturbances may cause a like degree of marasmus, few if any will show a regularly subnormal temperature. In conjunction with the low temperature the *slow pulse* is to be considered, though this alone is not of much value. The *paradoxic food reaction* is of much value, especially when it occurs without causing any change in the clinical picture other than the loss in weight. On the other hand, we must remember that in parenteral affections the tolerance for food is usually reduced, so that a dyspepsia may be easily

produced by increasing the food. The absence of physical findings other than those due to rapid wasting may help in a diagnosis.

Differential Diagnosis.—*Tuberculosis* offers the most difficulties. The *miliary* form often presents the same general picture of malnutrition; here, however, the temperature is usually elevated 1 to 2 degrees, and the facies lacks the eager expression of the case of decomposition; the weight-curve is steadily downward and there is usually present a slight diarrhea. The stool, passed three to four times a day, is grass-green and may contain mucus, but rarely curds. Cough is often present, and although there may be no râles over the lungs, still there is a distinct note of tympanoresonance on percussion. If the spleen is enlarged, the differentiation is not difficult. In the *tubercular intoxication,* where there is only a single focus of tubercular infection and a severe malnutrition resulting from this, the diagnosis is almost impossible. In both forms the von Pirquet reaction is of great value, since if positive at this age it almost invariably speaks for an active tuberculosis.

Marantic states are the rule in untreated cases of *congenital syphilis.* Here the difficulties are not so great as in tuberculosis. The skin eruptions, snuffles, enlarged spleen, and history usually gives a strong clue to the nature of the disturbance. In some cases where a single symptom arouses the suspicion of the physician, an energetic mercurial treatment may confirm existence of syphilis, since in congenital syphilis the state of malnutrition seems to be entirely the result of the infection, and proper treatment will produce results without much attention to diet.

In the older infants *syphilitic hydrocephalus* may cause

great difficulty if it is not remembered that a moderate hydrocephalus, which develops between the sixth and twelfth months, is usually syphilitic in nature, and practically always accompanied by a severe state of malnutrition. Besides the therapeutic tests the Wassermann reaction and the Lange gold chlorid reaction on the cerebrospinal fluid[1] are of great value, and should be used in all doubtful cases.

Chronic lung affections are not common at this age, and when present are readily diagnosed. After the sixth month, or even before, *adenoids* may be the direct cause of rather severe malnutrition, and should always be considered. The diagnosis of adenoids, as a rule, is not difficult, but it requires some judgment to determine just how much of the malnutrition is due to metabolic disturbances and how much to respiratory.

A neglected *pyelocystitis* may offer great difficulties, because at a late stage the temperature is often but little above normal, and the general symptoms, or, rather, absence of them, closely simulate a decomposition. The examination of the urine clears up the diagnosis.

Congenital heart disease is often accompanied by a most severe state of malnutrition, which even under the most favorable conditions may resist treatment of any and all kinds. The cyanosis and heart findings readily determine the source of the trouble.

Cretinism may offer some difficulty, but when thought of is usually easily diagnosed.

In *eczema* the problem is to determine in how much the malnutrition is the result of the eczema, and how much

[1] Grulee and Moody, Jour. Amer. Med. Assoc., 1913, lxi, 13.

dietetic errors may be to blame for the skin condition. The two are most intimately connected and can scarcely be regarded separately. In cases where vomiting is a marked symptom, *pylorospasm* or *pyloric stenosis* must be excluded. Pyloric tumor, reverse gastric peristalsis, vomiting of large amounts of food, and small ribbon-like feces, when all present, make the diagnosis easy. Perhaps the most important symptom is that of reverse gastric peristalsis, and this should be looked for in all cases of severe and continued vomiting. The duodenal catheter may here prove of great value, according to those who have had most experience with it.

Prognosis.—This, of course, depends to a great degree upon the severity of the case and the diet. Of the most severe cases the majority die. The younger the infant, the worse the outlook. The very young infants cannot be saved unless breast-milk can be procured. The institutional infants seem to be much less resistant than are those in private practice under the same conditions.

Symptoms of grave portent are cyanosis, steadily falling weight, and continued gastro-intestinal disturbance, such as vomiting and diarrhea. Collapse is a serious condition and usually is followed by death. The best gauge of the less severe cases is the reaction of the weight to increased amount of food. In those cases where an amount of food equal to 30 to 35 calories to the pound weight in twenty-four hours can be taken without producing a drop in weight or gastro-intestinal symptoms, the prognosis under the best circumstances is good. Much depends upon the possibility of obtaining the food best fitted for the infant, especially breast-milk. Hygienic surroundings, too, are of great im-

portance because of the lowered resistance to infections in these infants. On the whole, the condition is a very grave one, and requires in its treatment the finest judgment, not for one or two days, but often continued over many months. Nobecourt and Bidot[1] found an increase of the urea content of the spinal fluid with aggravation of the condition. This finding has recently been confirmed by Guidi.[2]

Treatment.—Attention to every detail is necessary if one wishes to treat these cases successfully. This applies not only to the diet, but to every factor of the daily existence of the child. With great care apparently hopeless cases can recover, while a slight error in judgment or a short relaxation in vigilance may undo the work of many weeks. In no disease of infancy is it so necessary to have the absolute confidence and co-operation of the mother or attendants of the child, and in none is so much patience and caution required.

Dietetic Treatment.—*Breast-milk* is not only the best food, but in many instances without it the case is almost hopeless. This must be given under direct supervision of the physician, especially if a wet-nurse is employed. No wet-nurse or mother should give all the milk from normally functionating glands to one of these infants. On the other hand, if the breast is employed for this infant alone in the early stages, such small quantities are given that the breasts become painful from distention, tend to dry up, and the milk, as a consequence, becomes poor. To obviate this difficulty the sick infant should be put to the breast for a short nursing

[1] Arch. d. Med. d. Enf., 1914, xvii, 663.

[2] Riv. d. Clin. Ped., 1916, xiv, 513.

period, and immediately following a well child should be given the breast until it is drained. This serves two purposes, it keeps the supply of milk in the breast in good condition and it gives to the sick infant a milk poor in fat, a very desirable thing. Many advise that the breast be given these infants as often as every two hours, but in the experience of the writer the four-hour interval here, as elsewhere, has given satisfactory results. At first the infant should be put to the breast for two minutes at each nursing, this being gradually increased to five, and then to ten minutes or longer. Care should be taken that no gastro-intestinal symptoms develop, or if they do, to return to the amount of food which the infant can tolerate. Sometimes it is possible to obtain breast-milk pumped from the breast of a woman who is nursing a normal infant. In such cases it is best to begin with 1 ounce every four hours and gradually increase, observing the same precautions. As a rule, breast-milk does not produce marked gains in weight in the first few days or weeks; in fact, such are not desirable. Stolte[1] has been able to produce distinct increase in weight by the use of breast-milk combined with butter-milk. There must always be a stage of reparation, during which the infant's stools return to normal, the temperature is increased to the normal mean, and the pulse-rate increases. Any attempt to produce a more rapid recovery is much more likely to be attended by failure than by success.

If it is necessary to nourish these infants on artificial food, in the opinion of the writer no food will take the place of albumin milk. At the present time if one has not the facilities for making this, a very good dried preparation can

[1]Monatsschr. f. Kinderheilk., 1912, xi (Orig.), 158.

be obtained and there is very little excuse for not employing it. I have no hesitation in saying that ordinary milk mixtures have never brought results in my experience in severe cases. In recent years I have been accustomed to start with larger quantities than formerly and I am persuaded that one runs less risk in the treatment of these cases if one starts with somewhat larger quantities. As a rule it is best to start with 2 to 2½ or 3 ounces of albumin milk to the pound weight in 24 hours; the sugar to be added is in the form of a maltose-dextrin mixture. One should never delay too long in adding this. As a rule in 24 hours it is safe to add ¼ to ½ ounce to the daily quantity. This should be rapidly increased to 1 or even 1¼ ounces. If the case is under good control, that is, in a hospital or in the hands of a competent trained nurse, one is justified in giving 1 ounce of 6 per cent. dextrose solution by mouth between feedings. One should always be careful, however, not to give this too long and also to stop as soon as the first signs of diarrhea appear. In some cases which the writer treated the results from the use of this dextrose solution have been remarkable. If the ordinary cow's milk mixture must be used it would seem to be wise to reduce the quantity of fat but I cannot advise, as formerly, that one take it out entirely and resort to small quantities of milk. It seems to me that the wisest course is to remove about ½ the cream from the milk and give 1½ to 2 ounces to the pound weight in 24 hours. The maltose-dextrin additions should be made in much the same manner as with the albumin milk. This food, however, is less frequently successful than the albumin milk and the dangers from its use are considerable.

Marriott[1] has advised the use of a mixture of buttermilk and corn syrup, the infants to be given of this 150 to 200 calories per kilo (75 to 100 calories per pound). The dextrose solution mentioned above may be given intravenously as advised by Dunn[2], or intraperitoneally.

Hygienic Treatment.—Too much stress cannot be laid on proper care in cases of decomposition. Fresh air must be had, and this should be neither too hot nor too cold. I am persuaded that collapse and death occur in many cases because these infants with subnormal temperatures are exposed to cold lake- or sea-breezes in institutions devoted to their care. If the weather is warm, the clothes should be thin and light; if it is cold, they should be heavy and thick. This pertains to outer wraps. The weight of the undergarments should remain the same, only the outer clothing being changed. Under no consideration should a case of decomposition be taken out-of-doors on a winter's day. On the other hand, the room in which it is kept should be thoroughly aired at all times, but at the same time kept warm.

These infants should not be worn out by constant handling, but should be allowed to conserve all their energies by lying quietly in the crib, the position being changed from time to time.

To attempt to quiet crying by handling is a step in the wrong direction, since a day or two of quiet in bed is enough in nearly all cases to insure against future discomfort. Bathing and the other routine duties should be even more strictly attended to than in the normal child.

[1] Jour. Am. Med. Assoc., 1919, lxxiii, 1173.
[2] Am. Jour. Dis. Child., 1917, xiv, 52.

Medicinal Treatment.—The only time when medicinal treatment is of any use is during a collapse. At this time stimulants are most necessary. Strychnin sulphate, to the amount of $\frac{1}{500}$ grain hypodermically every four hours, is the best. Alcohol is usually not well borne because soon vomited. Caffein citrate and camphorated oil may be of much value.

Serum Treatment.—The writer occasionally has had good results with blood transfusion and Clemente-Ferreira[1] has had success in these cases with the subcutaneous injection of 20 c.c. of horse serum. This was repeated once.

Symptomatic Treatment.—In collapse, besides stimulation, heat to the extremities and back is of much value. Water should be offered, but is rarely taken. In *vomiting,* stomach-washing and avoidance of all undue excitement are of much value. When stomach-washing is resorted to, one must be careful to do this at infrequent intervals and must always be prepared for treatment of an acute collapse. Very frequently if these infants are allowed to rest quietly after the bottle is taken the vomiting ceases. The chronic atonic *constipation* is best controlled by the use of suppositories.

[1] Arch. Latino-Amer., de Ped., 1920, xiv, 109.

CHAPTER XVI

INTOXICATION

(*Synonyms.*—Summer Diarrhea; Ileocolitis; Cholera Infantum; Toxicosis; Infectious Diarrhea; Dysentery.)

Definition.—An acute affection of the organism characterized by sudden onset, with collapse, high fever, diarrhea, vomiting, deep, pauseless breathing, leukocytosis, and mellituria (lactosuria), occuring most frequently in the summer months and in artificially fed babies living in poor hygienic surroundings.

Etiology.—*Predisposing Causes.*—This condition is far more prevalent among *artificially nourished* infants, the reasons for which will be discussed later. As to age, the idea that the "second summer" rather than the first is the one to be dreaded is probably because a large proportion of babies are nursed during the first summer, while practically all are, and all ought to be, on the bottle by the time the second summer comes. With this important exception, intoxications are more common in the first year of life and much more fatal. *Sex* and *race* seem to make no difference. *Previous alimentary disturbances* are a very important factor in the etiology. No child develops intoxication without having undergone a more or less severe disturbance of its internal metabolism through nutritional disorders. These disorders may be slight, as, for instance, a weight disturbance or a short period of dyspepsia, or they may be a severe form of decomposition, but in many instances they

prepare the ground for the harboring of the noxious chemical agent derived from the food or from bacteria. *Parenteral* affections of various kinds are frequently accompanied by attacks of intoxication which are of alimentary origin, but these will be considered elsewhere. *Infections and diseases* which have previously existed, but are not of an alimentary nature, frequently so deplete the organisms as to predispose to an intoxication.

The general predisposing factors are numerous and much more definite than the individual. *Heat* undoubtedly plays a very important part. Most cases develop in the hot summer months and are most numerous toward the end or just after a protracted hot-spell. Bleyer[1] found that such a large proportion of his cases developed in a temperature of 80° to 100°F. that he feels this must be a factor. The exact nature of the action of heat is not definitely determined. It has been thought that the heat produced bacterial growths in milk, and that by so doing caused a decomposition of that food which produced the intoxication. Again, it has been regarded as responsible in some unknown way for the appearance of the dysentery bacillus, which in turn has been blamed for so much of the summer diarrhea. Of late, however, the old idea that heat acts by producing heat-stroke and, therefore, is a direct cause of the condition in question, is gaining many adherents. Aside from any action which heat may have on the food, it would seem that it must have some great influence on the child itself, since the body surface in these infants is so great in proportion to the weight that any external heat must affect more deeply than in the adult the effort of the body to adjust

[1] Jour. Am. Med. Assn., 1915, lxv, 2161.

itself to external temperature. Many things besides the air temperature contribute to the production of heat or, rather, to its retention. One of the most serious errors is that of dressing these babies too warmly, as has been shown by the work of Helmholz[1] and McClure and Sauer.[2] The idea that every baby must have a flannel band to keep the "bowels warm" is a very prevalent one, and the use of this article of clothing, with many like errors, contributes in part to the infant morbidity of the summer months. Rietschel[3] sums up the effect of heat as follows: First, by direct action or acute heat intoxication; second, through chronic action by reducing the resistance of the child; and, third, by infection of the food, especially milk. Hot, poorly ventilated rooms, dirty, stinking surroundings, failure to bathe the infant as often as necessary, all lowering the vitality, help to pave the way for intoxication.

Active Causes.—The active causes of intoxication may be divided into three classes: (1) Some element of the food, *e. g.*, sugar; (2) decomposition of the food; (3) bacterial infection of the intestinal wall. It is altogether possible that each one of these may be the cause in a certain number of cases, so that the all-important thing to determine is not which alone is to blame, but rather the relative etiologic importance of each as Day and Gerstley[4] have suggested.

Finkelstein and Meyer have championed the idea that the *milk-sugar* of the food can of itself produce intoxication. This action of milk-sugar is aided greatly by the presence of

[1] Jour. Am. Med. Assn., 1914, lxiii, 1371.
[2] Am. Jour. Dis. Child., 1915, ix, 498; *ibid.*, 1915, x, 425.
[3] Jahrb. f. Kinderheilk., 1913, lxxviii, 312.
[4] Am. Jour. Dis. Child., 1915, ix, 233.

a high fat-content in the food. The removal of the sugar hastens the recovery. This action is not confined to milk-sugar, but occurs with cane- and grape-sugars, and less often with malt-sugar. In the opinion of the writer this sugar intoxication or, as Finkelstein and Meyer call it, "alimentary intoxication," accounts for a large proportion of the cases of intoxication, in spite of the fact that Porter and Dunne[1] have been able to produce nothing worse than slight dyspeptic symptoms by the administration of large quantities of milk and malt sugar. In how much the inorganic salts enter into this condition has not as yet been shown. The recent findings, in regard to the pyretic action of sugar and salt solutions when given subcutaneously (see Chapter IV), would seem to show that the action of sugar and salt must be an indirect one.

Czerny and Keller think that the "toxicosis" (a symptom-complex described by them which is identical with that of intoxication) is due to the decomposition of the food by bacteria, either before ingestion or after its passage into the intestinal canal. In their opinion the direct cause lies, in all probability, in the splitting of the fats into products which are directly irritating to the intestinal canal, and which when absorbed derange the internal metabolism. They do not bring any direct evidence of the existence of such decomposition products, but the opinion is supported by animal experiments.

Escherich was the first to suggest that bacterial infection of the intestinal canal was the cause of "summer diarrhea." He regarded the Bacillus coli communis as at fault. Since his time many investigators have taken it for granted that

[1] Am. Jour. Dis. Child., 1915, x, 77.

the condition was of bacterial origin, and search in the stool has been made for the causative agent. In this country the work of the Rockefeller Institute was directed along this line in 1902 and 1903, with the result that the Bacillus dysenteriæ (Flexner) was found in a large number of cases. The dysentery bacillus was found in only 20 per cent. of the cases of ileocolitis by Veeder, Kilduffe, and Denney,[1] and they state that its mere presence is not necessarily of etiologic value. The streptococcus has been championed by Jehle. Epidemics have been described by Moro and Escherich and by Finkelstein in which the Bacillus acidophilus seemed to be the causative factor, and by Cooper, where the Bacillus pyocyaneus was found in large numbers in the stools.

Bessau and Bossert[2], and Scheer[3] have found that the bacterial flora of the stomach and duodenum is definitely increased in intoxication. Porter, Morris and Meyer[4] ascribe much etiological importance to the fact that in intoxication there is a strongly putrefactive flora in the intestines.

The presence of the dysentery bacillus in the stools has in many cases been accompanied by agglutination of that organism by the blood of the patient, but in no case has there been any apparent benefit from the use of antidysenteric serum.

Okuba[5] has been able to produce the intestinal lesions of dysentery in animals by subcutaneous injection of dysen-

[1] Am. Jour. Dis. Child., 1912, iv, 75.
[2] Jahrb. f. Kinderheilk., 1919, lxxxix, 213.
[3] Jahrb. f. Kinderheilk., 1920, xcii, 328.
[4] Am. Jour. Dis. Child., 1919, xviii, 254.
[5] Am. Jour. Dis. Child., 1918, xvi, 376.

teric toxin. Schiff and Epstein[1] found the hay bacillus in the stools in a large proportion of their cases and ascribe to this some pathological importance.

On the whole, except in isolated epidemics, the bacterial theory of the origin of summer diarrhea has proved very unsatisfactory. As a causative factor of the secondary symptoms—*i. e.*, of those symptoms which develop after the onset of the trouble—bacteria have not been considered, and yet it would seem that here is their greatest etiologic value. An intestinal wall which has been altered both functionally and anatomically by a severe nutritional disturbance would probably offer favorable ground for the development of bacteria, which might accidentally be introduced *per orem* or *per rectum*, and these, once having gained a foothold, might easily produce secondary symptoms. The experience of anyone who has had much to do with these cases is that most of them, if seen within the first few hours, will respond to starvation treatment, and in twenty-four to forty-eight hours the symptoms of the acute condition will have disappeared. This would hardly be the case if an infection of the intestinal wall were the primary lesion. On the other hand, the heaped-up evidence of the presence of bacteria, which must be regarded as pathogenic, is so great as to make one hesitate to disregard infection entirely.

Mellanby[2] thinks that histamine is formed in the bowel in these cases and has an etiological importance. Marriott[3] has discussed in detail the condition underlying intoxication

[1] Monatsschr. f. Kinderheilk., 1921, xix, 289.

[2] Quart. Jour. of Med., 1916, IX, 165.

[3] Am. Jour. Dis Child., 1920, xx, 461.

and his idea of its cause. It would be impossible here to give these opinions the space which they deserve. He thinks that air hunger breathing may be explained on the basis of an acidosis but that there are other and more serious conditions than acidosis present. The clinical picture is not unlike that of wound shock. There is a lessened volume of flow of blood in these infants which accounts for the fact that acidosis is not overcome entirely by the administration of sodium bicarbonate. He does not think that glycosuria is of importance in producing symptoms but that it results from a diminution of the oxygen-carrying capacity of the blood. The leucocytosis and fever may be explained on the basis of dehydration and this dehydration may be explained by water loss as a result of the raising of body temperature by increase of external temperature. He thinks that the entire clinical picture may be explained on the basis of loss of water from the body and that while other factors are operative they are not necessary to explain this condition.

From our present knowledge it is probable that the primary cause of intoxication is a dietetic one, in the younger infants, due either to the sugar or salts, and in the older ones to more serious errors; decomposition of the food, in all probability, is a strong factor in the morbidity, but the specific action of pathogenic bacteria is secondary to the primary nutritional defect. It is impossible at present to estimate the real etiologic value of heat or the nature of its action, but probably in most cases it acts by materially reducing the resistance of the infant to chemical change or else prepares the infant's organism for such change. It should be noted here that there is definite evidence in this

condition of an increased permeability of the intestinal wall. It is conceivable that this is the primary condition caused by some factors, the nature of which we do not know, and that the toxic material whatever its nature is absorbed only through an altered intestinal wall.

Pathogenesis.—The exact nature of intoxication is by no means clear. That the condition is not only intestinal, but metabolic, is shown conclusively by the presence of lactose (milk-sugar) in the urine during the acute stages. Even though the diarrhea is not violent, there is an enormous loss of water through the lungs (Meyer). Hess[1] has found that the lipase of the pancreatic juice is deficient, but trypsin and amylopsin are present in large amounts. The results of Holt and his co-workers[2] with a high protein food are suggestive, but would be of more value if there had been less of salts, especially sodium, in the food used.

Stransky[3], and Schloss[4] have both noted the increase in the non-protein nitrogen of the blood. Marriott and Sisson[5] found that the lipoid content of the blood was no greater in intoxication than in starving infants without acidosis.

If the diarrhea is severe, as it usually is, the loss of water through the bowel is accompanied by the various inorganic salts in solution, and hence there is a distinct tendency to demineralization. The ammonia-content of the urine is high, which speaks for an acidosis. Howland and Marriott[6]

[1] Am. Jour. Dis. Child., 1913, v, 268.

[2] Am. Jour. Dis. Child., 1912, iv, 265.

[3] Monatsschr. f. Kinderheilk., 1920, xix, 10.

[4] Am. Jour. Dis. Child., 1918, xv, 165.

[5] Am. Jour. Dis. Child., 1918, xvi, 75.

[6] Am. Jour. Dis. Child., 1916, xi, 309; xii, 459.

have shown beyond a doubt that in the acute stages of an intoxication a very severe acidosis exists.

Schloss and Stetson[1] have corroborated these findings. Ylppö[2] feels that acidosis in intoxication is in part a hunger acidosis.

In regard to the loss of ash in cases of intoxication Aron[3] found that per kilogram body weight loss in intoxicated infants was about the same as that of one having no nourishment disturbance. He thinks therefore that an intoxicated infant suffers no more deeply nor extensively from cell destruction than the normal child under like conditions.

We have, therefore, a severe disturbance of internal metabolism, which shows evidence of acidosis, loss of water and salts, and a deficiency in the sugar-consuming properties (Jundell).[4] The relative importance of these factors is unknown, and, in fact, may vary probably greatly in the given case, but they furnish, when taken as a whole, valuable hints for treatment.

Symptoms.—The *onset* is sudden, with rise of temperature, vomiting, and watery stools. It is always preceded by some nutritional disturbance, most often a dyspepsia. The temperature mounts steadily, so that in a few hours it has reached 104° or 105°F. Vomiting may or may not be present, but if present is usually at the very onset of the disturbance. The discharge of watery feces is usually, but by no means always, seen. Collapse is often seen, or the whole may be ushered in by convulsions.

[1] Am. Jour. Dis. Child., 1917, xiii, 218.

[2] Hunger und Intoxikationsacidosis, Berlin, 1916.

[3] Jahrb. f. Kinderheilk., 1917, lxxxvi, 128.

[4] Zeitschr. f. Kinderheilk., 1913, viii, 235.

Fig. 25.—Intoxication, showing facies.

Fig. 26.—Intoxication, showing facies in more comatose state. Same case as in Fig. 25.

The *facies* is very characteristic. The eyes stare into space and have a sunken appearance. The mouth is open and the lips seem parched and drawn. Slight twitchings of the muscles are seen about the corners of the eyes and mouth. At intervals the muscles of the face contract, as if the infant would cry, but very often no sound is made, and they again relax. No attention is paid to small external stimuli. This is the facies which gives the infant the "sick" look, so often noticed and commented on by the attendants; and it is this facies which leads the physician to give a graver prognosis than the severity of the case warrants. The eyes soon become sunken, as does the fontanel.

There is a rapid *loss of weight* in a few hours from the time of onset. This usually amounts to about 8 ounces, but may be much greater; at times as much as 2 pounds. This loss is due, in large measure, to the loss of water (in the forms of solution of the various salts), and its degree depends, to a great extent, upon the severity of the diarrhea. Much of the water, however, is lost through the lungs. After the initial loss in weight the supplying of water to the system may cause a temporary rise, but this, in turn, is usually quickly followed by a return to the original low point. After the first loss the weight remains stationary or slowly declines, but rarely returns rapidly to the original height. This is, in part, due to the necessary limitation of the food, but any attempt to force this up is very likely to bring on another crisis.

The *temperature* mounts quickly at the onset, usually reaching 104°F. and often going to 106°F. The return to normal, if starvation diet is immediately instituted, is

almost as rapid as the rise, so that within twenty-four hours the temperature has dropped below 100°F., and then or later often becomes subnormal. It is not infrequent to encounter on the second or third day a second rise of temperature; this, however, is never high, rarely over 101°F., but may continue for some time, especially if there is sugar or a large amount of sodium chlorid in the food (or administered as a continuous saline enema). It is very unusual for an intoxication of but a few hours' duration to maintain a high temperature if a starvation diet with plenty of water is administered, and any such continuation of temperature should lead to a diligent search for some hidden cause. If, however, the intoxication is of some days' duration, it is usual for the temperature to continue high for some days, and even irregular for as long as two weeks. It is these cases in which secondary infection may play an important rôle. The temperature-curve of an intoxication is, if all circumstances are carefully weighed, of much diagnostic value and should be closely watched.

The *pulse* in general follows the temperature, and is rapid and snappy; in the neglected cases, weak. A decrease in the intensity of the heart-tones, a lack of sharp distinction, or especially only a single audible apical tone, are signs of bad omen and call for stimulation. In examination of the heart with the *x*-ray Czerny[1] has shown that in very severe cases the heart shadow is often extremely reduced in size. This he does not attribute to the intoxication, but to the action of the intoxication on a heart with disturbed innervation. The *respiration* is rapid and pauseless, and has often led to the erroneous diagnosis of pneu-

[1] Jahrb. f. Kinderheilk., 1914, lxxx, 601.

monia. The upper and anterior part of the chest is high and broadened, due to the congestion of the lungs. In the protracted cases along the vertebral column may be heard the fine crackling râles of hypostatic pneumonia. In intoxication the lungs, to some extent, act as excretory organs, throwing off an appreciable amount of water. After the acute stage the respirations rapidly become more quiet, though often being somewhat increased in frequency.

The *gastro-intestinal symptoms* are marked. The onset of the attack is often accompanied by *vomiting*, but, as a rule, this does not continue throughout the course, and is usually not an alarming symptom. *Eructation of gas* is not a frequent symptom. *Diarrhea* is nearly always present and is usually very severe. There are ten to thirty or even forty stools a day. The stool is watery, sometimes having a putrefactive odor, but more often with an odor resembling that of a damp cellar. Sometimes it is colorless, but more often of a light or grass-green color; at times, however, it is yellow. Mucus is present in large quantities, as are small curds (fat-soaps or mucus-balls) blood is rarely present in the early stages, but is found only later, when the condition has become more or less chronic, and is due to ulceration of the intestinal wall. The blood, when present, is found mixed with the mucus. Pus is occasionally found. Chemically Holt, Courtney and Fales[1] have shown that the stools contain a greater proportion of water, protein and sodium and potassium salts. An intoxication is not necessarily accompanied by a severe diarrhea. In fact, the stools may be increased to only four or five a day, and rarely

[1] Am. Jour. Dis. Child., 1915, ix, 213.

a severe constipation is present. *Flatus* is frequently passed with the stool and *meteorism*, either at the onset or more often later, is a very serious complication. This meteorism is due to a partial paresis of the bowel wall from the altered circulation (venous congestion), and hence is a symptom the presence of which is a source of anxiety. *Prolapse of the rectum* not rarely follows the acute stage of intoxication. In fat infants the *liver* is often enlarged, due to fatty infiltration.

The disturbance in the central *nervous* system is the result of venous congestion. Usually these children are only semiconscious, and respond to stimuli by a cry or gesture, which shows the clouded state of the cerebral functions. The child may, in the severest stage, at times lapse into unconsciousness. More rarely there is distinct delirium. In some cases the neck is held rigid, so rigid, in fact, that it is most suggestive of meningitis. Twitchings of the muscles of the face and extremities are frequently seen.

When disturbed the infant is likely to utter a weak, plaintive cry, which usually ceases when the irritation is stopped. During convalescence the child remains very cross and irritable and the sleep is light. Convulsions very frequently complicate intoxication, and occur in those children showing the spasmophilic diathesis (see later).

The *skin* shows nothing unusual. It is dry and hot and very pale, due to the congestion of the internal organs. A gray-violet color denotes failing circulation and is a bad sign. If an eczema was previously present, it sometimes disappears, only to reappear during the convalescence. The *tissue turgor* is markedly and rapidly reduced.

Rarely extensive generalized edema is seen in these cases

during early convalescence and indicates a rather serious disturbance.

The *disturbance* of the *circulation* is the cause of the pallor of the skin and the cerebral symptoms, as well as hypostatic pneumonia, which often develops early in the reparative stage. Meteorism is a result of congestion of the intestinal wall.

Heart weakness is a bad sign, and is shown by weakened tones and by hearing but one tone at the apex.

The *blood* shows a leukocytosis of 15,000 to 20,000, the increase being in the polymorphonuclear variety. Anemia, if present, is slight, and, on the contrary, the blood may be very concentrated as a result of the rapid loss of water. Salge[1] has found distinct concentration of the blood in 1 case.

The *urine,* if obtained in the early stages, shows albumin and casts. Before all the sugar of the food is excreted this appears in the urine. The kind of sugar in the urine depends upon the kind of sugar in the food. Lactose is most common (from the milk-sugar), but galactose and saccharose have been found. The presence of sugar in the urine denotes a serious disturbance of the function of the intestinal epithelium and of the internal metabolism. Hirschfeld[2] found the adrenalin eye-test positive in 20 cases, and thinks that glycosuria in intoxication is an indication of the involvement of the sympathetic nervous system which is brought about by the destruction of the albumin.

Morgenstern[3] thinks that the presence of a large quantity

[1] Zeitschr. f. Kinderheilk., 1912, iv, 92.
[2] Jahrb. f. Kinderheilk., 1913, lxxviii, 197.
[3] Zeitschr. f. Kinderheilk., 1919, xix, 129.

of uric acid crystals in the urine is a sign of grave disorder. He was able to find uric acid infarcts in all of the cases of death from intoxication.

Complications.—Pneumonia, either of the hypostatic or bronchial variety, is occasionally seen. In the former, the lowered vitality renders the condition serious. When bronchopneumonia is present, it is very difficult to determine whether the pneumonia is a complication of the intoxication or the intoxication of the pneumonia. In most instances the latter is true. In all cases the condition is a serious one. *Convulsions* are likely to occur at the onset of the symptoms and greatly increase the danger. In severe cases *generalized edema* not infrequently occurs, and, when present, is indicative of a serious condition. The exact nature of the edematous process is not understood. *Furunculosis* may develop during convalescence, as may intertrigo and other skin affections. *Pyelocystitis* is not often a complication. It must be remembered that the presence of some other disease does not exclude intoxication, but rather predisposes to it, so that very often we may regard it as a complication.

Sequelæ.—The most important condition resulting from intoxication is *decomposition.* This is especially likely in young infants and in those in which the food is poorly dosed after the acute stage is over. By some it is thought that the bladder becomes infected with the colon bacillus from the diarrhea and a *pyelocystitis* results. As seen above, *pneumonia* may occur during convalescence.

Diagnosis.—The chief diagnostic symptoms of intoxication are the sudden onset with collapse, rapid rise in temperature, vomiting, deep, pauseless breathing, severe diar-

rhea (usually ten to fifteen green watery mucous stools a day), leukocytosis and albumin, casts and lactose in the urine. The typical facies is of much diagnostic importance and the general relaxed semicomatose condition is suggestive. The quick reaction, when the food is withdrawn and water given in large quantities, is not found in other affections.

The enlargement of the liver, when present after the beginning of the attacks and absent before, is a positive physical finding. In the early stages the diarrhea is never more severe in degree than are the general findings; in fact, the child has the appearance of being sicker than the general symptoms or the underlying condition would seem to warrant, in striking contrast to other affections producing in general the same symptoms. The absence of physical findings is of much value.

Differential Diagnosis.—Of the other nutritional disturbances, only *dyspepsia* is likely to give much trouble from a diagnostic standpoint. In general, dyspepsia has the same symptoms, only to a much slighter degree. The fever is so low as to be disregarded, the diarrhea is not so severe, the sensorium is not clouded, leukocytosis is slight, and lactose is not found in the urine. Since the disturbances are of the same general nature, the difference in the clinical picture is a difference in degree rather than in kind.

With those cases of intoxication having a severe constipation, *weight disturbance* may be confused, but the clinical picture of the latter is so much less severe than is that of intoxication that even a superficial observation of the cases is sufficient to distinguish between them. The severe cases of *decomposition* with diarrhea are not likely to present any difficulty (see table, pp. 284, 285).

Differential Diagnosis Table of Nutritional Disturbances of Infancy

Symptoms	Weight disturbances	Dyspepsia	Decomposition	Intoxication
Weight	Stationary.	Slight loss.	Stationary, or gradual loss.	Rapid loss.
Temperature	Slight, variable.	97° to 100°F.	Subnormal.	High fever.
Pulse	......	Slight increase.	Slow.	Rapid.
Respiration	......	......	Slow.	Deep, rapid, and pauseless.
Stool	Constipation. Hard, white or gray.	Four to five a day; semi-fluid, green.	Constipation or slight diarrhea; hard or semi-fluid, green.	Ten to forty per day; usually watery; variable color.
Mucus	......	Present.	Present or absent.	Much.
Curds	Sometimes.	Present.	Sometimes.	Frequently.
Blood				Occasionally.
Vomit	Not frequently.	Usually.	Not frequently.	Almost always.
Meteorism	Frequent.	Frequent.	Frequent.	Frequent.
Eructation	Frequent.	Frequent.	Frequent.	Frequent.

Urine:				
Ammonia	Increased.	Increased.	Not increased.	Increased.
Albumin	Absent.	Absent.	Absent.	Present.
Lactose	Absent	Absent.	Absent.	Present.
Casts	Absent.	Absent.	Absent.	Present.
Sensorium	Undisturbed; cross.	Undisturbed; cross and fretful.	Undisturbed; not cross.	Semicomatose.
Skin	Pale; inguinal intertrigo.	Usually pale.	Often brownish.	Often cyanotic.
Turgor	Slightly reduced.	Reduced.	Markedly reduced.	Markedly and rapidly reduced.
General state	Not emaciated.	Somewhat reduced.	Emaciation.	Rapid emaciation.
Immunity	Slightly reduced.	Distinctly reduced.	Markedly reduced.	Markedly reduced.
Blood	......	......	......	Leukocytes to 20,000.
Complications and sequelæ	Eczema frequently; decomposition.	Pyelocystitis, decomposition, intoxication.	Furunculosis, hypostatic pneumonia, dyspepsia, intoxication.	Peumonia, convulsions, infections.
Prognosis	Good.	Good.	Grave.	Very grave.

Perhaps of all the acute diseases, the clinical picture of *pyelocystitis* most resembles that of intoxication.

The temperature is high, the leukocytosis is marked, diarrhea is usually present, and there is a general pallor of the skin. Pyelocystitis occurs most frequently in female infants, hence there is greater difficulty in obtaining specimens of urine except by catheterization. Again, if urine is not obtained as a routine measure, and it usually is not, the clinical picture is very confusing. The temperature of pyelocystitis is usually very high, but has marked remissions of 3 to 4 degrees, which occur at no regular intervals, but are best distinguished by the suddenness of the change. The temperature shows no tendency to reduce on starvation diet. Very frequently, especially in recent cases, within two to four days after the administration of a urinary antiseptic, the temperature drops to normal and remains so. The diarrhea, as a rule, is not marked. The general condition is not so severe as in intoxication, and there is not the same tendency to collapse or the same clouding of the sensorium. Physical examination is almost negative, except that in neglected cases there may bè a tenderness over the kidneys. The rapid breathing of the type found in intoxication is not encountered. The diagnosis is finally conclusive when the examination of the urine shows pus-cells in large numbers.

Otitis media, if accompanied by vomiting and diarrhea, as it frequently is, has a course not very different from that of intoxication. The temperature is often high, does not respond to starvation diet. The child cries and is cross rather than semicomatose. There is no marked loss in weight. Pressure over the external auditory meatus

usually brings distinct manifestations of discomfort, and examination of the tympanum discloses a red, bulging membrane. Paracentesis is always followed by a rapid fall in temperature and subsidence of all symptoms.

The rapid respiration may suggest *pneumonia.* Physical examination is nearly always conclusive, but other symptoms may help. In pneumonia the sensorium is usually clear. There is no marked loss in weight at the beginning of the disease. The temperature is high, but is not influenced by the starvation period. The cheeks are often flushed, and the expiratory grunt is quite characteristic. Diarrhea is a complication, and is, as a rule, not severe. The physical findings, if definite, will, of course, help greatly in differentiating the two conditions.

Intoxication often simulates very closely a *tubercular meningitis.* In the latter the temperature may be high, though more frequently it is moderate (101° to 102°F.) and irregular. The spleen is often enlarged. Not infrequently a tympanic note on percussion with fine crackling râles are found over the lungs. The neck is somewhat more rigid than in intoxication, but Kernig's sign is very often not present. Involvement of the cranial nerves, as shown by strabismus, etc., is found only rather late. A positive von Pirquet reaction and a cerebrospinal fluid, showing globulin, lymphocytosis, and especially tubercle bacilli, make the diagnosis positive. The diarrhea, if present at all, is not severe, and vomiting tends to assume the projectile type. Although a slight leukocytosis may be present in tubercular meningitis, this is never so high as in intoxication.

The differentiation of *acute miliary tuberculosis* is very

similar to that of tubercular meningitis, except that there is no tendency to the localization of symptoms. The sensorium is not clouded; in fact, the children seem rather brighter than one would expect. The spleen is nearly always enlarged. The von Pirquet test is valuable except in the last stages, in which it may be negative. It may be impossible to differentiate these cases on the first examination, but usually after a few days' observation, the failure to react to starvation diet, the character of the temperature, and the general advance of all symptoms, are enough, with the Pirquet reaction, to confirm one's previous suspicions of miliary tuberculosis.

Almost every febrile condition accompanied by diarrhea which may occur in infancy may offer some reason for considering intoxication. Among others may be mentioned anterior poliomyelitis, the acute infectious diseases, acute endocarditis, typhoid fever, and malaria. Each of these may have its special points of resemblance, but these are so remote or the condition so unusual that it is useless to go into the details of their differentiation here.

Prognosis.—The prognosis depends usually upon two factors: the previous state of health of the child and the promptness with which proper treatment is instituted. In most cases the danger to life is in the first twenty-four hours. Unfavorable conditions are decomposition, age under three months, and a previous diet of denaturized food, such as condensed milk and malted milk. The result in infants previously fed on condensed milk seems to be especially bad. Where intoxication complicates some other disease, such as pneumonia, the outlook is exceedingly grave.

On starvation diet the acute febrile stage lasts rarely

longer than forty-eight hours and is usually completed in twenty-four hours. The reparative stage may, however, last many weeks, and depends upon the previous state of health and the care with which the food is watched during this period. Any attempt to force the food is likely to produce the opposite effect from that intended. A case in which the temperature falls to normal after twenty-four hours and remains so, even though a slight diarrhea is present, gives a good prognosis. There is no way of telling, however, how long the reparative stage will last. A fever irregularly or continuously high for some days is a serious sign, because it denotes secondary infection of some kind. A very severe watery diarrhea at the outset is an alarming symptom, and calls for strenuous efforts to overcome it and its effects. Vomiting is not often a serious symptom, but if persistent may be very alarming. Meteorism is a symptom which is hard to treat, and represents a severe disturbance. Convulsions and pneumonia are complications which are much to be feared.

Treatment.—*Prophylaxis.*—Much can be done to prevent the occurrence of intoxication, and it is against this condition that most of the efforts to reduce infant mortality have been directed. There is no question but that these efforts have done much good, but they have given the laity the impression that the solution of the problem could be attained by general measures, whereas, in its last analysis, the solution lies only in attention to the individual child. Pure milk is a very desirable, perhaps necessary, help in dealing with the infant morbidity, but the indispensable factor is, and must always be, the properly trained physician.

In caring for the individual child we should be careful

during the hot weather to see that the bath is properly attended to, that the milk is clean and fresh, that unnecessary clothing is removed (and this means frequently everything but the diaper), and that the child is kept in the open air as much as possible. The sleeping apartments should be well aired during the day.

Most important among the preventive measures is the attention to the composition of the food.

Above all, the sugar should be reduced to a minimum. A common error is to reduce the sugar in the food and allow its use to sweeten water. The amount of food should not be increased during the hot weather, and, in fact, it is often well to remove some of the ingredients, especially carbohydrates. "Table" food should under no consideration be given, and no attempt should be made to force up the weight of a breast-fed infant by giving food other than the breast.

Much has been written in condemnation of pacifiers, teething rings, etc., and different shaped bottles, but such crusades, though creditable, tend to divert our attention from the main issue—the food—and give an excuse to the physician whose conscience will allow him to grasp at such straws. The general public, especially the nursing profession, is quick to pick up such palpable evidence of error, and so, from an etiologic standpoint, the pacifier has been exalted far above its relative importance.

Dietetic Treatment.—At the onset of the intoxication two indications are pre-eminent: first, stop food; second, supply water. This is done by giving in place of the regular bottle a like amount of barley-water sweetened with saccharin (1 grain to the quart). A bottle should be given every four hours. Between bottles, water sweetened in the

same manner should be offered the infant. Every attempt to supply water to the depleted system should be made. Helmholz[1] suggests the use subcutaneously of an 8 per cent. dextrose solution in amounts of 50 to 100 c.c., in order to prevent the rapid loss in weight. Large doses of alkalis are indicated to overcome the acidosis. These may be given in the form of enemas (retention or continuous) of Fischer's solution[2] or in extreme cases, the same solution may be used intravenously. As suggested by McLean and Lang[3] fluids may be introduced intraperitoneally. In the writer's experience this method has been followed by excellent results. The danger is practically nil and the inconvenience to the patient very slight. Larger quantities of fluid may be introduced by this route than in any other way and the results are frequently quite satisfactory. After twenty-four or, at the most, forty-eight hours of this starvation diet we should begin to give some food. The various constituents of milk and carbohydrate foods are irritating to the child in the following order: sugar, fat, starch, and protein (of cows' milk); therefore, if we can have a food which contains only protein we will fulfil our indications best, and next to this stands the starch. A food used by the writer for some time consists of curds of skimmed milk suspended in arrow-root water or in 5 per cent. gelatin solution.[4] (See Chapter X.) The curds of about 1½ ounces of skimmed milk to the pound weight in twenty-four hours are given in a requisite amount of arrow-root water,

[1] Report before the Chicago Pediatric Society, Nov., 1913.

[2] Fischer's solution: Sodium bicarbonate 10.0 gms., water 1000 c.c.

[3] Am. Jour. Dis. Child., 1920, xix, 359.

[4] Grulee, Interstate Med. Jour., 1913, xx, 41.

sweetened with saccharin. The bottle is given every four hours. Within twenty-four to forty-eight hours about half the skimmed milk curds are replaced with a like amount of whole milk curds, and then the mixture replaced 1 ounce at a time with skimmed milk, and this in turn with whole milk, carbohydrates being gradually added in the form of malt-food and starch, but never milk- or cane-sugar. The chief objection to this method of treatment lies in the difficulty in preparing the food, but if the directions are carefully followed this need not be great. The whole period, from the beginning of the starvation diet to the substitution of milk for the curds mixture, should not consume longer than a week. If a good buttermilk can be made this can be used, giving substantially the albumin-milk.

Where it is not deemed necessary to go to the trouble of making the curd mixture, buttermilk or skimmed milk may be used. Commercial buttermilk is not to be thought of, and the preparation of buttermilk for private use from the cultures on the market, though apparently easy, is not always a uniform process. Buttermilk contains less milk-sugar than does skimmed milk, and hence is to be preferred if properly prepared. After the starvation period of twenty-four to forty-eight hours, about 1 ounce of buttermilk or skimmed milk to the pound weight in twenty-four hours should be given, properly diluted with water or barley-water and sweetened with saccharin. As in other conditions, the bottle should not be given oftener than once in four hours. This is continued for perhaps a week, the skimmed milk or buttermilk being increased to 1½ ounces to the pound weight. This is then replaced every day by 1 or 2 ounces of whole milk, and during this time the car-

bohydrates added in the same manner as described above. In children suffering from severe losses of weight, Stolte[1] has been able to get the best results by a combination of the use of buttermilk and breast-milk.

In infants over a year old it is not necessary generally to take such precautions. After the period of starvation diet the child is given whole milk diluted with an equal amount of boiled water, beginning with about 1 ounce of milk to the pound weight and increasing to 1¼ ounces; then cereals are added in small amounts. For several years I have found it inadvisable to use albumin-water or eggs in any form in these cases. Vegetable soup containing very little salt may be given, but meat or chicken broth are not to be used even during convalescence.

If it is possible to give these infants *breast-milk* after the starvation period, it is nearly always advisable to do so. The breast should never be given oftener than every four hours, and the length of the nursing period should be limited to one to two minutes at first, and then gradually lengthened to ten minutes. At times it is necessary to pump the breast, centrifuge the milk, or allow it to stand and remove the fat. As in other disturbances of nutrition in the infant, breast-milk is a valuable asset during the reparative stage, but to obtain its full benefits great caution is necessary.

Hygienic Treatment.—Fresh air is a very essential part of the treatment. These children should be kept out-of-doors where possible, otherwise in a well-ventilated room. The clothing, in hot weather, should consist of nothing but a diaper and thin slip. If possible, the air should be kept

[1] Monatsschr. f. Kinderheilk., 1912, xi (Orig.), 158.

in motion by an electric fan if there is no breeze. Cleanliness is absolutely necessary, not only by bathing, but by careful attention to the buttocks after defecation. It is well not to disturb the child by washing the mouth, but the nostrils should be cleaned at least once a day.

Medicinal Treatment.—It has long been the custom to administer a cathartic at the onset of a diarrhea, the reason for which is not plain. The bowel itself is doing all in its power to excrete the noxious material which it contains and cannot be forced to do more. Any cathartic tends only to irritate an already irritated mucosa and make matters worse. In the case of calomel, which is the cathartic most often chosen, the antiseptic action is so slight as to be entirely disregarded. Castor oil may even increase the danger because of the fat in it. It is more than likely that calomel does little harm, but it is absolutely useless and, therefore, need not be given. It is the custom of the writer never to give a cathartic in the acute stages of a diarrhea.

Intestinal astringents may rarely be useful in the later stages of secondary infection, but even here they are of doubtful value. They are usually given as enemas, in the form of tannic acid or the tannates, in a solution of about 1 or 2 per cent., and it is altogether likely that simple enemas would produce just as good results. Sinclair[1] has obtained good results by the use of cultures of the lactic acid bacillus. In the experience of the writer these cultures give the best results when given in liquid form and during the stage of convalescence.

Serum Treatment.—With the idea that the colon bacillus may be an etiologic factor in producing intoxication,

[1] Arch. Ped., 1913, xxx, 529.

Plantenga[1] had reported very good results with a polyvalent B. coli serum. This was given in amounts of 20 to 30 c.c. and repeated. Mertz[2] has reported like results with a slightly different serum, as has Hamburger.[3]

Symptomatic Treatment.—For the *fever*, hydrotherapeutic measures are the only ones to be considered. Cold sponges or even cold baths, if the temperature is very high at the onset, are of much value. It is well not to have the temperature of the water for a cold bath lower than 90°F. An ice-cap to the head is a very simple and effective measure. Colonic flushings of tepid water are an aid.

When the *diarrhea* is very severe, so that a stool is passed every few minutes and the infant is in imminent danger of death through rapid loss of fluid, opium is indicated. This is best given in the form of paregoric in doses in proportion to the age of the child (♏j to ij under three months; three to six months, ♏iij to v; six to eighteen months, not over ♏viij), and should not be repeated more than once, and never in less than two hours. In the later stages, when the diarrhea has become more or less chronic, flushings offer the best measure for relief. Perhaps the simple saline flushing will do the work best because it is non-irritating. The medicated flushings, containing such antiseptics as silver nitrate, acetozone, etc., have never met with any great degree of success, but may be tried in severe cases. The benefit of bismuth in these diarrheas is doubtful. When given it should be in the form of the subnitrate or subcarbonate, suspended with acacia. Large doses are not

[1] Jahrb. f. Kinderheilk., 1917, lxxxvi, 175.

[2] Monatsschr. f. Kinderheilk., 1920, xviii, 401.

[3] Jahrb. f. Kinderheilk., 1920, xciii, 25.

advisable, 5 grains every four hours will give whatever beneficial results are to be obtained from its administration.

Rowe[1] advises the use of animal charcoal in the treatment of these diarrheas. The writer's experience has been such as to lead him to think that animal or vegetable charcoal when given after the acute stages is of great value in controlling the diarrhea. It should be given in doses of 15 to 20 grains every four hours and as the diarrhea gets better the amount gradually reduced.

Vomiting is rarely a symptom which causes much distress. When persistent, stomach-washing is of much value; at times even one lavage is sufficient to stop a severe vomiting. Bismuth and cerium oxalate act less quickly, but produce very good results. When *eructation of gas* is distressing, charcoal may be given.

Meteorism is best combated by means of colonic flushings of normal salt solution, or of a few grains of finely divided charcoal in normal salt solution. Care should be observed not to introduce too much fluid, for the paretic condition of the bowel may allow its distention and cause serious collapse from pressure on the diaphragm. The abdomen should always be carefully watched and the amount of fluid used estimated. Sometimes by introducing a flushing-tube well up into the bowel and submerging the free end in hot water the gas passes out through the water. Turpentine stupes, if used, must be very judiciously handled.

Prolapse of the rectum is usually benefited most by the gaining strength and weight of the child. An enema of 1 to 2 per cent. tannic acid solution may be given once or

[1] Archiv. of Ped., 1918, xxxv, 406.

twice a day by means of a one-picce rubber ear-syringe. These syringes usually hold 1 ounce, the proper dose of the solution.

Collapse calls for prompt and effective measures. The continuous saline enema is of the most value. The reservoir is elevated about 1 to 2 feet above the patient, and the enema tube clamped off with an artery forceps so that the flow is regulated to about 1 drop in every two to three seconds; the tube is then introduced into the rectum and allowed to remain there. In a short time the fluid ceases to be absorbed and is returned. The tube is then removed for a short time and reinserted. If the diarrhea is not too severe, this measure is very effective, but it may in some cases keep up the temperature. Subcutaneous salines act more quickly, but it is not usually convenient to give them. A solution of sodium chlorid (7.0) to potassium chlorid (0.1) and calcium chlorid (0.2) in 100 c.c. of water has been suggested, but with this the writer has had no experience. Salines may also be given intraperitoneally with excellent results. As a medicinal agent strychnin sulphate, $\frac{1}{500}$ grain given hypodermically every four hours, is good. Camphorated oil, caffein citrate, etc., may be given in the same way. Alcohol in the form of brandy (♏v to x in a teaspoonful of water every four hours) or Tokay wine (teaspoonful in equal amount of water) is given, but may disturb the stomach.

The treatment of *convulsions* will be taken up later. If the *delirium* is marked and the child extremely restless, chloral hydrate, 1 to 2 grains in an ounce of water, may be given rectally. The *comatose state* is best combated by hydrotherapeutic measures and the withdrawal of food.

For the treatment of edema Comby[1] recommends the treatment suggested by Hume, that is, the administration of 5 to 10 mm. of adrenalin hydrochlorate (1:10,000) either by mouth or subcutaneously two or three times a day.

[1] Archiv. Med. les Enfants, 1912, xv, 858.

CHAPTER XVII

SYMPTOMS AND THEIR CAUSES

ERUCTATION OF GAS

Gas in the stomach may come from three sources: the swallowing of air, decomposition of food in the stomach, and regurgitation from the duodenum through the pylorus. Usener[1] regards the swallowing of air as an important cause of gas in the stomach. Smith and Lewald[2] have demonstrated air in the stomach of infants by means of the *x*-ray.

It is very likely that swallowing air is one of the most important causes of accumulation of gas in the stomach. How great a factor decomposition of the food in the stomach is we cannot say. It is very suggestive, however, that irritation of the gastro-intestinal tract produced by some disturbance is oftentimes accompanied by eructation of gas.

When the food is given at such frequent intervals that all of the previous feeding has not had time to pass the pylorus before new food is introduced into the stomach, there is an accumulation and consequent stagnation in that organ which leads to decomposition and the production of gas. This is augmented if, for some reason, there is a delayed muscular action.

Eructation is more frequent in young infants and prob-

[1] Zeitschr. f. Kinderheilk., 1912, v, 440.

[2] Am. Jour. Dis. Child., 1915, ix, 261.

ably more often encountered in those fed at the breast. It is usually found with such of the milder varieties of nutritional disturbances as dyspepsia, but may be present in other forms. It is frequently accompanied by colic, especially in breast-fed infants. Increased formation of mucus in the nasopharynx or bronchi, when this is swallowed, not infrequently leads to gas formation in the stomach.

Aside from regulation of the underlying condition, treatment may be directed to the stomach. Such general measures as lengthening of the interval between feedings and reduction of the sugar- and fat-content are perhaps the most valuable. Stomach-washing, even if only resorted to once or twice, may overcome the disturbance. When accompanied by vomiting, medication in the form of bismuth subnitrate, suspended in acacia to which is added powdered charcoal to the amount of about 5 grains to the dose, may give relief. (The charcoal is not well suspended, so the mixture must be well shaken before using.) Change of position frequently gives temporary relief.

VOMITING

Among the gastro-intestinal symptoms most frequently encountered in disturbances of nutrition is vomiting. In the infant several distinct forms can be noted; and a differentiation is often of much clinical value. In young infants *regurgitation* is especially common. This consists of a simple raising of the food from the stomach, and is apparently not accompanied by discomfort. Another type which is seen is the usual form of *vomiting accompanied by more or less discomfort.* Closely allied to this type is the

ejection of small amounts of food from the mouth as a result of a forceful eructation of gas. *Projectile vomiting* is that form where appreciable quantities of food are projected with force, sometimes several feet. Perhaps here it would be well to mention "rumination." This peculiar and, fortunately, rare condition consists in the regurgitation back into the mouth, after ingestion, of the food taken; there the food is held for some time and again swallowed. This act is seemingly voluntary, since it is usually accompanied by some such act as a strong suction on the fingers.[1]

Regurgitation of food is most often seen in infants under three months of age, and is perhaps more frequent in those nourished at the breast. Mechanical causes, such as disturbance immediately after nursing, tight bands, etc., are the usual causes. However, the condition in very weak infants may be the result of overfilling of the stomach. In many cases this type of vomiting occurs in nervous children. The material vomited is usually the unchanged milk, since regurgitation occurs almost immediately after nursing. This may have an acid or "sour" odor, due to the mixture with it of the gastric juice. As is readily seen, this is not a condition of grave import, and removal of the cause is usually easy and quite sufficient to produce a cure.

True vomiting is the result of some distinct local or general disturbance. It is most frequently seen in cases of dyspepsia or more severe alimentary disturbance, due to some grave error in diet. In the experience of the writer true vomiting has been much more common in breast-fed than in artifically fed infants, but, on the other hand, when it

[1] Grulee: Am. Jour. Dis. Child., 1917, xiv, 210.

occurred in artifically fed infants its presence was the indication of a more menacing condition. In part, this experience is doubtless due to the practice of using low fat amounts in preparing food for infants, and in advising a four-hour interval between feedings. One must recognize, etiologically at least, three types of vomiting: first, that due to disturbance of the stomach alone; second, that due to nutritional disturbance as a whole; and third, that due to parenteral affections. The first is most often the result of one or both of two errors—high fat-content and short intervals between feedings. In the breast-fed infant a short interval necessarily causes a high fat-content, since the breast is drained at each nursing, and hence there is always a large amount of fat present in the milk. Other things being equal, the condition is likely to be much more severe in artificially fed infants, but, on the whole, is more frequent in breast fed, since in the artificially fed the severity of the condition is such that it practically always results in a distinct nutritional disturbance if it is not properly treated. This form of vomiting may result, too, from too high sugar-content (milk-sugar, malt-extract) of the food, but this is less common because of the tendency to more severe disturbances, where the sugar-content is too high. I have never seen this caused by high protein-content nor by large amounts of fluid to the single nursing. In fact, I have been struck by the fact that if the interval between feedings is sufficiently long, even on large single feedings, vomiting of this type is distinctly uncommon. The underlying condition is doubtless an irritation of the mucous membrane of the stomach, as is evidenced by the presence of large quantities of mucus in the vomitus.

Fig. 27.—Stomach washing.

Vomiting usually occurs from one-half hour to an hour after feeding, but may be almost immediate. The vomiting is usually accompanied by the expulsion of more or less gas, and consists of curds mixed with mucus. Oftentimes there are expelled large cheesy masses, which are probably the result of stagnation and accumulation of the food of former feedings, as a result of the failure of the stomach to empty itself because of too short intervals. If not recognized and treated early, this condition almost invariably passes into the second type. In the treatment, the best and most lasting results are to be obtained by regulation of the diet. Most important, often alone sufficient, is the lengthening of the interval between feedings, where this has been less than four hours. Especially in breast-fed infants one cannot help being struck by the benefit which this simple measure brings. It acts not only by giving the stomach a rest, but also by allowing the breast gland to recover after each nursing, and hence reduces the proportion of fat in the breast-milk. The next measure is the correction of the dietetic error in the composition of the food. If this be either sugar or fat, a reduction of the substance is productive of good results. Vomiting is rarely caused by the amount of sugar contained in an unsweetened cows' milk mixture, so that usually admirable results may be obtained by temporary diet of diluted skimmed milk. This should only be resorted to in severe cases, since properly dosed whole milk dilutions are usually sufficient. Where the case is a severe one, stomach-washing is frequently indicated. Often one washing is enough to produce a cure; sometimes it must be repeated once a day for several days. In cases accompanied by much gas, a mix-

ture of charcoal in milk of bismuth,[1] although of unsightly appearance, may give excellent results.

The second type has been so thoroughly discussed under the various nutritional disturbances previously treated in this work that no further attention will be given it here. The third type will be taken up in the chapters devoted to infant feeding in parenteral diseases. One should always bear in mind the vomiting of intussusception.

As to projectile vomiting, it is usually associated with acute cerebrospinal meningitis, but this disease is fortunately not very common during infancy, so that this type is not often seen. In congenital pyloric stenosis, which is seen most often in very young infants, the vomiting is very frequently of this type.

For the treatment of rumination many different measures have been advised, such as thickening the food, feeding with buttermilk or alkalinized kefir (Peiser)[2] or plugging the nostrils (Strauch)[3] but each of these measures has failed in the cases treated by the writer.

Batchelor and Batchelor[4] had excellent results by the use of a cap which was so fitted as to hold up the lower jaw and prevent its motion.

METEORISM

Meteorism may be due to one or both of two factors: accumulation of gas in the intestines from decomposition of the food and paresis of the intestinal wall. The sig-

[1] About 2 or 3 grains of charcoal to a half-teaspoonful of milk of bismuth one-half hour after feeding.

[2] Monatsschr. f. Kinderheilk., 1914, xiii, 61.

[3] Jour. Am. Med. Assn., 1915, lxv, 678.

[4] Am. Jour. Dis. Child., 1919, xvii, 43.

nificance of its presence depends, in large measure, upon the general condition of the infant. In a child with intoxication, meteorism is a sign of marked disturbance of the intestinal blood-supply (paresis of the intestinal wall), and hence is a serious condition.

On the other hand, a moderate distention of the abdomen in a dyspeptic breast-fed infant is an aggravating, but not a serious symptom.

The condition occurs rather frequently in cases of dyspepsia and intoxication, and occasionally in weight disturbance. At times it may complicate a parenteral affection, such as pneumonia.

Meteorism is usually relieved by colonic flushing, but this must be repeated once or twice a day, since no permanent relief is obtained by one washing. The fluid most used is normal salt solution. If the case is severe, finely powdered charcoal may be added. Intestinal antiseptics, either by mouth or in enemas or flushings, are of no special value. In some cases relief is obtained by introducing a tube well up into the colon and submerging the external end in hot water. Turpentine stupes are sometimes used, but care must be taken or these will blister the skin of the abdomen.

DIARRHEA

This consists essentially of an increased number of stools in a given time. The stools are practically always of softer consistency than normal. There is only one underlying principle involved in diarrhea, and that is increased muscular action in the intestines. This increased muscular action is due to irritation in some instances from irritating substances found within the canal, but it is conceivable

that a very active peristalsis may result from the efforts of the internal metabolism to rid itself of poison through the intestinal canal. There is a type of diarrhea found both in congential syphilis and miliary tuberculosis which strongly suggests such a circumstance as the sole factor.

Almost all the diseases of infancy, whether of gastro-intestinal nature or not, may be and frequently are accompained by diarrhea. The condition is so frequent that the diagnosis of diarrhea so often made conveys to the mind absolutely no idea of the underlying condition. The severest diarrheas are almost always the signs of an intoxication; on the other hand, an intoxication may give only slight diarrhea.

No classification of diarrhea is practicable, since so many different factors enter into the subject that the attempt must result in excluding or slighting some of them, and thus be a failure. One should always analyze a diarrhea according to its various characteristics, and in doing this more directly arrive at the nature of the process. The *number* of stools depends not only on the severity of the irritation, but also upon the portion of the intestines most affected. If the small intestine be most involved, the diarrhea is usually not so violent. The number of stools are then four to five a day. If the colon is involved the number of the stools amounts to ten to twenty a day. If both are involved, the result is, of course, the larger number of stools. The *consistency* of these stools is determined usually by the degree of the intestinal irritation. Here, too, the anatomic location of the lesion may play some part, since water is largely absorbed by the colon, so that the rapidity with which the stool passes through the colon determines to a

degree the amount of water which it contains. It should be remembered that water is never excreted without holding in solution a certain quantity of the various salts, so that a severe watery diarrhea is dangerous, not only because it dehydrates the system, but also because of its demineralizing action. The *odor* of the stool is caused by the gases formed by the bacterial processes in the canal. If putrefactive processes predominate, the odor is offensive; if fermentative, there is little odor. The excessive formation of fatty acids gives a sour, rancid odor. Putrefaction is rarely the result of decomposition of proteins of the food, but usually is due to decomposition of the intestinal mucus. The *reaction* is alkaline if putrefaction predominates; acid, if fermentation or fatty acid formation control. It is possible that the reaction of the intestinal content largely determines the variety of bacteria found, rather than the reverse. The *color* of the stool is due to the bile (unless some substance such as beets, bismuth, etc., has been given). The bile-salt in the small intestine is bilirubin. The normal stool usually shows hydrobilirubin, a reduction product. If the bilirubin is still further reduced, urobilinogen is formed. This is colorless and is found in the hard, dry, white stools of a fat constipation (see Weight Disturbance). The oxidation product of bilirubin is biliverdin, and is the cause of the green color so frequently seen in the diarrheic stool. Very frequently a stool becomes green after standing, the oxidation taking place in the air. It is very necessary, therefore, that the stool should be examined fresh or that one should take into account the possibility of the above-mentioned change.

Mucus occurs in the stools either in balls or strings.

The former are the result of peristaltic action, and hence come from the small intestine, while the latter come from the colon. *Blood* in macroscopic quantities denotes, as a rule, ulceration at some point in the intestines. A hard stool may cause erosion just above or at the sphincter, and the fecal mass have blood on the surface. The blood in ileocolitis is always intimately mixed with mucus. Occult blood in the stool from the duodenal ulcers of decomposition (Helmholz, Flesch) has been found. When prolapse of the rectum exists, very frequently blood mixed with mucus is found in the stool. This, however, is, as a rule, only in one place and not intimately mixed with the rest of the stool.

Curds are found in four forms, two of which are fat masses and two from the proteins. The fatty curds occur as white, granular, sand-like masses resembling portions of the stool of a fat constipation, or as small flocculent masses resembling soft curds of milk, but of a yellow color. The protein curds are most often balls of mucus. The other protein curd is the large, smooth, white or gray bean-like mass, sometimes translucent, which frequently occurs in an otherwise normal stool. Talbot[1] has shown by animal experimentation that these curds contain cows' milk casein. Maccone[2] has demonstrated the same with the precipitin reaction.

Almost simultaneously Brennemann[3] and Ibrahim[4] have shown that if the milk is boiled these masses disappear from

[1] Arch. Ped., 1910, xxvii, 440.
[2] La Pediatria, 1918, xxvi, 270.
[3] Am. Jour. Dis. Child., 1911, i, 341.
[4] Monatsschr. f. Kinderheilk., 1911, x, 55.

PLATE VIII

Large casein curds in otherwise normal stool.

the stool, while if the raw milk is given they reappear. Hess[1] believes that such casein masses are formed in the stomach.

Microscopically, many different kinds of *bacteria* are present. The diarrheic stool is Gram negative, except in those epidemics where the Bacillus acidophilus has been found in large numbers. Jehle regards the presence of streptococci in large numbers in the stools at the very onset of the diarrhea as significant. In stools containing the dysentery bacillus this organism can frequently be seen as an intracellular Gram-negative bacillus.

The treatment of diarrhea must be the treatment of the causal condition. No local measures should be taken without first diagnosing the exact cause. In some cases where the stools are very frequent and watery it is necessary to check the diarrhea with opiates. In most cases, however, it is best to attempt to allay the symptoms with colonic flushings of normal salt solution if general measures are not sufficient. Bismuth mixtures are usually of little value and antiseptic mixtures are neither necessary nor effective.

CONSTIPATION

There is some question about the true meaning of constipation. Sometimes in the breast-fed infant the amount of food is very small, and as a result the stool is passed perhaps only once in forty-eight hours. In the writer's opinion this is not a true constipation, but rather an underfeeding. Constipation presupposes a food residue in the bowel, which for some reason the intestinal musculature does not move along as rapidly as in normal conditions. This state may be due to the hardness of the fecal mass or

[1] Amer. Jour. Dis. of Child., 1913, v, 457.

to the inertness of the bowel, or to both. In most cases it is very hard to determine which is more to blame at a given time. Primarily, the hardness of the feces usually leads to constipation and resulting inertness of the intestinal musculature.

The cause of constipation is very often only indirectly due to dietetic errors. Especially in the breast-fed baby it is practically always due to ill-advised medication in the early weeks of life. Castor oil or colonic flushings are commonly resorted to by the nurse without the physician's orders, or with his sanction when the infant shows the first sign of colic. This procedure is repeated frequently enough so that the bowel becomes used to this excessive stimulation and requires it. An atonic constipation results. In the artificially fed infant constipation is often due to a relatively too high fat-content in the food or due to inertness of the bowel following an acute diarrheic attack. Constipation is much more frequent in winter than in summer.

In the treatment the rule should be never to give drugs except as a last resort. Of the other measures at our command, the most useful are suppositories. The gluten suppositories rarely are sufficiently irritating for our purpose. The long glycerin suppository is often very effective. This is introduced into the rectum, one end being held in a fold of the diaper. At the home suppositories may be improvised from soap or an oiled paper-cone. In using suppositories one should always be careful to introduce them at the same time each day in order to train the bowel to regularity, a very important feature of the treatment. When suppositories are not effective, for a few days simple enemas may be given. To the food may be added orange-

juice, prune-juice, or syrup from figs. As previously mentioned Gerstenberger has not found that orange juice has a laxative action. If drugs must be used, calomel and castor oil, because of their rather drastic action, should be reserved for the severest cases. Milk of magnesia in ½- to 1-teaspoonful doses once a day is often effective. Various combinations of senna may give relief. Olive oil is often given, but in most cases it rather aggravates than relieves the condition, while in others it is responsible for a mild dyspepsia. In a few cases it apparently is quite effective.

PART IV

NUTRITION IN OTHER CONDITIONS

CHAPTER XVIII

THE PREMATURE INFANT

THE premature infant presents problems due to underdevelopment. This underdevelopment is not confined to nor does it predominate in the gastro-intestinal tract, but affects the organism as a whole. We have, then, the same problem of infant feeding exaggerated, *i. e.*, the underdeveloped gastro-intestinal tract required to supply a rapidly growing organism and the internal metabolism to take care of the material conveyed to it for use.

Utheim[1] found that the protein percentage in the blood was much lower in premature infants than in those at full term, being reduced as low as 4 per cent. Ylppö[2] has described what he characterizes as an outspoken acidotic condition in these babies. Hamilton[3] found a very low calcium retention in premature babies during the first months of life. The retention was sufficient, however, where the intake exceeded 200 mgms.

[1] Am. Jour. Dis. Child., 1920, xx, 366.

[2] Hunger und Intoxikationsacidosis, Berlin, 1916.

[3] Am. Jour. Dis. Child., 1920, xx, 316.

According to Budin[1] the premature infant is exposed to danger from three sources—chilling, improper dosage of nourishment, and infection from surroundings and attendants. The effect of the body temperature is readily seen from the tablulation of the mortality as taken from his lectures.

We see from this table how unfavorably a low temperature influences the premature infant.

The high mortality is very striking when we know that the hospital in which Budin made his observations was well

	Temperature on entrance					
	32°C. (90°F.) or under			32° to 33°C. (90°–92.3°F.)		
Weight	Died	Lived	Mortality, Per cent.	Died	Lived	Mortality, Per cent.
1500 gm. (3 lb.) or less	101	2	98.0	70	2	97.3
1500 to 2000 gm. (3–4½ lb.)	38	1	97.5	71	12	85.6
Over 2000 gm. (4½ lb.)	6	2	75.0	9	4	69.2

equipped with incubators and that the food was supplied by wet-nurses.

In caring for the premature infant it is, therefore, very necessary that the heat of the body be conserved. This, of course, is best done by means of the specially constructed incubators. These are not often at our disposal, and chill-

[1] The Nursling, London (about 1909), Lectures 1 and 2. The result of large experience as put forth in these lectures, which are freely quoted from in the text, is of inestimable value to one interested in the subject.

ing of the infant even for a short time may be fatal, so that removal of a child to an incubator is often inadvisable. A fairly satisfactory temporary incubator may be made by placing a small infant's bath-tub or other metal vessel in a large vessel containing hot water, the smaller vessel being propped up from the bottom. The water must be kept at a constant heat of 105° to 110°F. The infant is then wrapped in cotton, the whole body being enclosed with the exception of the face. It is then placed on a thick mass of cotton in the bottom of the smaller vessel, covered with cotton and surrounded with hot-water bags, being careful not to place these so that their weight falls directly on the infant. Under these conditions it is very inconvenient to change or nurse the infant, but the materials mentioned can all be obtained at a moment's notice.

It is self-evident that no attendant should be affected with any disturbance of an infectious nature. This applies not only to the acute infectious diseases, but also to such conditions as influenza, nasopharyngitis, tonsillitis, etc.

In feeding the premature infant the first food to be considered is breast-milk. If an artificial food is to be considered, the best results have been obtained by the writer with albumin milk.

In the nutrition, three things must be considered: the manner in which the food shall be given, the length of the interval between feedings, and the amount to be given at a single nursing.

Most of these infants are unable to grasp the nipple, so that we must resort to pumping the breasts and giving the milk with medicine dropper, Breck feeder, or tube. Feed-

ing by gavage is very simple, but the food must be introduced into the stomach slowly and in small quantities. It is usually difficult to produce and keep up the flow of milk in the breasts by artificial means, so that every attempt should be made to have the infant take the nipple.[1] In case of vomiting some benefit may be gained by setting the milk aside on ice and removing the fat, or, better, removing the fat by centrifuge.

The length of the interval must be determined by the amount of food taken at a single feeding. An interval of one and one-half to two hours is usually employed, but Litzenberg[2] has obtained excellent results with a four-hour interval, and these results agree very well with the experience of the writer.

As in other conditions, the amount of food must be determined by the condition of the child. Undernourishment is shown by a stationary or falling weight and by cyanotic attacks; overfeeding, by vomiting and diarrhea. There is much disagreement as to the caloric value of the food which these infants should obtain. Birk[3] gives convincing proofs that the energy quotient should not exceed that of the full-term child, that is, 100 to 110 calories per kilo, while Samelson[4] states that it should vary between 115 and 150. Budin gives the following table of the *average* amounts of milk taken by these infants, but, as he remarks, these represent only average figures, and should serve as a guide together with such other data as may be gathered:

[1] See Chap. IX, p. 147, "Treatment."

[2] Amer. Jour. Dis. of Child., 1912, iv, 391.

[3] Monatsschr. f. Kinderheilk., 1910, ix (Orig.), 279.

[4] Zeitschr. f. Kinderheilk., 1911, ii, 18.

	Infants weighing less than 1800 gm. (about 4 pounds)	Infants weighing from 1800 to 2200 gm. (4–5 pounds)	Infants weighing from 2200 to 2500 gm. (5–5½ pounds)
	11 infants	31 infants	25 infants
Second day.....	115 gm. (4 oz.)	129 gm. (4½ oz.)	180 gm. (6 oz.)
Third day......	160 gm. (5½ oz.)	175 gm. (6 oz.)	236 gm. (8½ oz.)
Fourth day.....	210 gm. (7½ oz.)	226 gm. (8 oz.)	295 gm. (10½ oz.)
Fifth day......	225 gm. (8 oz.)	308 gm. (11 oz.)	335 gm. (11¾ oz.)
Sixth day......	250 gm. (8¾ oz.)	324 gm. (11¼ oz.)	370 gm. (12½ oz.)
Seventh day....	280 gm. (10 oz.)	335 gm. (11¾ oz.)	375 gm. (12½ oz.)
Eighth day.....	285 gm. (10 oz.)	350 gm. (12¼ oz.)	385 gm. (13 oz.)
Ninth day......	310 gm. (11 oz.)	380 gm. (13 oz.)	415 gm. (14½ oz.)
Tenth day......	320 gm. (11½ oz.)	410 gm. (14½ oz.)	425 gm. (15 oz.)

Schick[1] advises that to each 100 c.c. of breast milk 17 gms. of beet sugar be added. This food, however, should not be continued for longer than 5 to 6 weeks.

If these children are to be fed artificially one may, in a fair proportion of cases, get good results with the use of albumin-milk. This should be given not oftener than every four hours and to the amount of 1 ounce at a feeding (undiluted) at the beginning. This is rapidly increased to 2 ounces and a malt food added in teaspoonful doses.

[1] Zeitschr. f. Kinderheilk., 1920, xxvii, 57.

CHAPTER XIX

THE EXUDATIVE DIATHESIS (CZERNY)

Definition.—The exudative diathesis is a congenital anomaly of the organism which usually affects all members of a family. At birth no signs are present by which its presence can be determined, but in the course of a few months or even less well-defined tendencies, such as distinct predisposition to eczematous conditions of the skin and to infections of the respiratory tract, are to be noticed. All symptoms are exaggerated by uncleanliness, a high fat-content in the food, and a life among nervous people.

Etiology.—The condition, as such, exists, but we as yet do not understand its exact nature or its cause. So far as is at present known, its manifestations are confined to childhood, but it is highly probable that such an important factor in the health of the child would in some way affect that of the adult. It is present more often in the city than in the country, and is so frequently a part of the life-history of the parents that it may be regarded as an inherited taint. No one who is familiar with the manifestations of exudative diathesis will hesitate to assert its great frequency in all classes and especially among the city poor. It is interesting ing to note that Hoobler[1] gives a suppressed anaphylaxis from the protein of cow's milk as the cause of a group of symptoms which correspond to those of exudative diathesis.

[1] Am. Jour. Dis. Child., 1916, xii, 129.

Schlutz and Larson,[1] after making precipitin reactions on the blood, came to the conclusion that "definite anaphylaxis to foreign protein occurs in exudative diathesis and that probably the majority of phenomena occurring in this condition are of an anaphylactic nature."

Symptomatology.—This condition may be present in any child, but two distinct types present themselves which seem to be most often affected. The one is the pale, puny, congenitally delicate infant; the other, the fat, robust, apparently healthy child. One thing is common to all the manifestations of this diathesis, and that is the distinct tendency to increased severity from uncleanliness (hence infection), an increase of fat in the food, and an evironment which tends to strain the nervous system. The most important symptoms are those referable to the skin, the respiratory tract, and body weight.

Body Weight.—After birth these infants may remain stationary in weight for a month, in spite of the fact that conditions are ideal. After this time the increase is rapid, but they never quite attain the normal. After removal from the breast constipation quickly develops, and only ceases when the fat-content of the food is reduced to a minimum. This would suggest a congenital anomaly of metabolism. Much earlier than healthy children these infants are able to assimilate starch, and they gain well on, and seem to need, starchy food. It is never well to attempt to attain a rapid gain in weight, because this is frequently followed by a weight disturbance or a nutritional disorder of a severe degree. Intercurrent infections are frequent and often cause a weight standstill.

[1] Arch. of Ped., 1918, xxxv, 705.

Skin Symptoms.—The most frequent skin affection is seen in the scalp and is very often entirely disregarded. The *cradle cap* is a grayish or yellowish-gray discoloration of the scalp in the region of the large fontanel. It is most often regarded as "dirt," and the mother's efforts are directed toward its removal. Perhaps for a short time these efforts may be attended by success, but the reappearance of the cradle cap is certain. In the lighter forms the cradle cap consists of many discrete areas of brownish, grayish, or grayish-yellow color in the scalp covering the anterior fontanel. These are somewhat scaly and can with effort be removed. As the condition becomes worse, these areas are joined together by other similar areas, and gradually the crust increases in thickness. As it becomes thicker the color becomes more yellow, but at this stage the whole mass is quite dry. The next stage is that of seborrheic eczema, in which the area is much larger, sometimes taking up the entire scalp. The crusts are large, yellow, thick, and exude a seropurulent fluid. Itching is not very marked.

The skin eruption next in frequency is the *milk eczema.* In very young infants the cheeks are seen to be red. Ordinarily the cheeks of young infants are not red, even when they are out in the air, so that the redness alone should at once attract our attention. On close examination it is seen that the red area is very definitely bounded and does not gradually shade off into the surrounding skin. Instead of being confined to the cheek, it passes backward along the skin over the zygomatic process toward the ear. On the surface of this reddened area are seen fine scales. A slight eczematous condition frequently develops on this area,

beginning, as a rule, in the middle of the cheek. This is extremely itchy, and infection from scratching may cause an extensive eczema.

Another very frequent skin manifestation is what, for want of a better name, has been called *intertrigo*. This occurs in the folds of the skin and is most characteristically encountered behind the ears. It is primarily a simple rawness, but is usually covered with a few crusts. Intertrigo is also found in the folds of the neck and in the axilla. A rawness in the inguinal folds without other manifestations of exudative diathesis is nearly always the result of an irritating urine, and should not be confounded with the true intertrigo of this affection.

Prurigo or *strophulus* is rare in this country. In fat infants it is found as large wheals, especially on the buttocks and extensor surfaces of the extremities. In thin infants the lesions are more papular. Itching depends upon external conditions and the nervous constitution of the child, but usually it is present to a very annoying degree. The lesion is one which is frequently found after infancy, and is produced, according to Czerny, by dietetic errors.

Freund[1] described a peculiar tendency of the *hair* on the top of the head to be directed upward. It is resistant to all attempts at control. The hair over the upper part of the forehead is very short, and this gives the appearance of a high forehead with the hair-line beginning well back.

Rachmilewitsch[2] produced a characteristic skin reaction in children with exudative diathesis by excoriating the skin and applying a mustard paste. There developed a broad,

[1] Monatsschr. f. Kinderheilk., 1910, ix (Orig.), 62.

[2] Jahrb. f. Kinderheilk., 1913, lxxvii, 176.

white wheal with a hyperemic border, and there was exudation at the point of scarification.

Respiratory Symptoms.—Most characteristic of the symptoms of the exudative diathesis which refer to the respiratory system is their tendency to repetition. No matter what portion is involved, this same tendency is manifested. Repeated attacks of *pharyngitis* occur, which are soon followed by an ever-increasing enlargement of the lymphoid tissue in the nasopharynx and the tonsils, with resulting chronic hypertrophy and its consequences. Repeated attacks of follicular tonsillitis is another symptom. This involvement of the lymphoid tissue of the pharynx and tonsils is, according to Czerny's idea, of secondary importance, the primary infection occurring not in the lymphoid tissue, but in the mucous membrane of the nasopharynx. I cannot partake of this view, because I have repeatedly seen this condition relieved for years by a complete removal of the adenoid tissue and the tonsils. Any subsequent enlargement of the tonsils was always due to the failure of removal of the entire tonsil at the operation. Another condition (rare in my experience) which Czerny mentions is repeated asthmatic attacks. These he believes to be due to an acute bronchitis, and the severity of the asthmatic symptoms to depend upon the nervous condition of the child. In exudative diathesis the mucous membrane of the air-passages is always more or less involved.

Gastro-intestinal Tract.—This condition seems to be peculiarly free from gastro-intestinal symptoms. The only symptom, however, which appears and disappears without any regard to outside factors is the *geographic tongue.* This shows as a white exudate of irregular outline on the

tongue surface. Peculiar to this is the fact that it never retains the same extent or shape, but changes from day to day. *Fetor ex ore* may be noticed due to decomposition in the crypts of the tonsils. Attacks of anorexia occur, but are rather the result of a superimposed nervous constitution than to the exudative diathesis itself.

Other Symptoms.—Vulvitis and balanitis are encountered. In the eyes, blepharitis is rather frequent, and Czerny ascribes phlyctenules to this condition and not to tuberculosis (scrophulosis). Whether this be true in all cases cannot at present be definitely determined, but I have repeatedly seen phlyctenular conjunctivitis improved by placing the child on a carbohydrate and vegetable rich diet, a result which one would rather expect to obtain with an addition of fat to the food if the underlying condition were tubercular. Lust[1] and Beck[2] have found an increase in the cell-content of the urine.

Immunity.—These children are very prone to infection of any kind. This is perhaps especially true of the acute infectious diseases. Every measure, such as maternal nursing, fresh air, etc., should for this reason be taken to raise the resistance of the child.

Blood.—The findings of Helmholz,[3] in examining the blood of infants suffering with exudative diathesis, are interesting. He first found that in the eczema which is present in exudative diathesis there is an *eosinophilia* amounting in the active stage to as much as 36 per cent., while in the scrofulous eczema there was a reduction in the

[1] Monatsschr. f. Kinderheilk., 1912, x, 420.
[2] *Ibid.*, 1913, xi, 468.
[3] Jahrb. f. Kinderheilk., 1909, lxix, 153.

number of eosinophiles. Benfey[1] reports a case where eosinophilia existed previous to the appearance of marked symptoms of exudative diathesis. What was more interesting was that the *opsonic index* was normal or increased in exudative diathesis. Liefmann[2] found no regular uric acid increase in the blood. Schippers,[3] in examining the lipoid content of the blood in normal children and those with exudative diathesis, found that the neutral fat in the latter condition is reduced almost one-half. The cholesterin was about the same; the cholesterin ester was somewhat reduced and the phosphatids slightly increased. Stefano[4] found a hypocholesteremia which he thinks was due to increased elimination. Strathmann-Herwed[5] could find very little variation in the cholesterol content of the blood in exudative diathesis. Beumer[6] had the same results. Lederer[7] found that there was no characteristic variation from normal in the water-content of the blood, but that sudden increase of water was accompanied by the appearance of exudative symptoms.

Prognosis.—In just how far the presence of an exudative diathesis affects the health of a given child it is very hard to say. It is undoubtedly true that these children have a marked predisposition to infections, and that their tolerance for food, especially fat, is reduced.

The active symptoms, such as eczema, etc., usually dis-

[1] Monatsschr. f. Kinderheilk., 1912, xi (Orig.), 421.

[2] Zeitschr. f. Kinderheilk., 1915, xii, 227.

[3] Jahrb. f. Kinderheilk., 1920, xciii, 151.

[4] La Pediatria, 1918, xxvi, 1.

[5] Monatsschr. f. Kinderheilk., 1920, xix, 20.

[6] Monatsschr. f. Kinderheilk., 1919, xv, 581.

[7] Zeitschr. f. Kinderheilk., 1914, x, 472.

appear toward the middle or end of the second year. The tendency to attacks of nasopharyngitis and tonsillitis exists long after that time.

These children are often of a decidedly nervous temperament and are less able to withstand nervous shocks, even of slight degree, than are normal children of the same age.

As to the outlook of continued ill health throughout life, we can only say that there may be a close relation between this condition in infancy and the so-called uric-acid diathesis in the adult.

Treatment.—*Hygienic measures* are very necessary. Fresh air is essential to their health. Even in cold weather the child should be out-of-doors many hours a day. A good plan is to have the infant sleep out in the sun (in cold weather) during the day and at night in a well-ventilated room. We must endeavor to keep these children warm in winter and cool in summer. Hardening processes are not advisable; in fact, may do distinct harm by shocking the nervous system. Careful attention should be paid to the health of the children's attendants. These should always be free from infections.

General rules of diet apply to these cases as to the normal infant. Certain tendencies are characteristic and should be anticipated. Most important of these is the inability to tolerate milk-fat in large quantities, or even, at times, in small quantities. It is often necessary to reduce this in the food, but rarely to remove it entirely.

There is not the same intolerance for cod-liver oil, and this may be given in small doses. The tolerance for starch, on the other hand, is increased. Appreciable quantities can be taken with advantage as early as the third month.

Breast-milk is best for these infants because it tends to keep up the resistance, but it often is advisable to substitute one feeding of a starch mixture for one nursing period.

Toward the end of the first year in the severer cases gruels may be given in place of one or two milk feedings.

During the second year all fatty foods should be avoided. Eggs should not be given. Only in rare instances is it advisable to give over 1½ pints of milk in twenty-four hours. Vegetables of almost all kinds, but especially spinach, beets, and carrots, should be given. Oranges, apples, prunes, and figs are well taken. Cereals of all kinds should form the bulk of the diet.

In the experience of the writer oatmeal has sometimes proven to be rather irritating to the intestinal canal in these cases and to have increased the severity of the eczematous processes.

Medicinal treatment is to be avoided chiefly because of the effect it has on the nervous system of the child. Drugs should be given only to overcome temporary disturbances and not in the form of tonics. For this reason there is some question as to the usefulness of cod-liver oil.

These children should early be taught to play with others, and not be confined to the company of adults or of children of the same family. All reference by the parents to the child's ills should be carefully avoided in its presence, and too much sympathy for small reason should not be given. In no other way will one be able to develop a normal nervous system in a case of exudative diathesis.

CHAPTER XX

THE SPASMOPHILIC DIATHESIS[1]

(*Synonyms.*—Tetany; Spasmophilia; Convulsions.)

Definition.—The spasmophilic diathesis is a condition characterized by an increased electric irritability and a tendency to spasm-like contraction of one or more groups of muscles.

Etiology.—The spasmophilic diathesis rarely manifests itself in the breast-fed infant. It is more often seen in those children whose diet has been rich in fat and who have had a resulting fat constipation. More cases are seen in the spring and fall than in the summer, although almost invariably the attacks are preceded by gastro-intestinal disturbances; these latter, however, may not be of a severe nature. From the frequency of their occurrence in the same individual and the apparent disturbance of the calcium metabolism in each, there seems to be a very close relation between the spasmophilic diathesis and rickets.

Manifestations of the condition occur more frequently in children after the age of six months up to two years, but Rosenstern[2] has recently called attention to its frequent combination with congenital debility, and Kehrer[3] reports 6 cases of tetany in the newborn. Klose,[4] however, con-

[1] It is the intention of this article to discuss the subject only in so far as it is of interest from the standpoint of infant feeding. This will be true also for the chapters on Rickets, Scurvy, etc.

[2] Zeitschr. f. Kinderheilk., 1913, viii, 171.

[3] Jahrb. f. Kinderheilk., 1913, lxxvii, 629.

[4] Arch. f. Kinderheilk., 1919, lxvii, 439.

cludes that there are no clinical observations as yet which show the lowest age at which manifestations of tetany occur. He thinks it best to place this time about the end of the second month.

The exact nature of this condition is not known. The occurrence of tetany in animals after removal of the parathyroid glands has had several investigators. Escherich[1] attempts to connect tetany in the infant with lesions of the parathyroid glands. However, no definite relation between the two as yet has been proved, since many cases have been reported in which hemorrhage in all the parathyroid glands could be demonstrated, and yet no spasmophilic symptoms had occurred during life. It is, of course, possible that in these cases the elements of the parathyroid secretion were made up in some other way. But certainly it cannot be positively asserted that there is a definite relation between lesions of the parathyroid gland and the occurrence of symptoms of the spasmophilic diathesis. Pincherle and Maggesi[2] found alteration in the endocrine glands especially those of branchiogenic origin (thymus, thyroid, parathyroid) with great regularity at autopsy.

As to whether the condition is due to an absolute or relative reduction of the calcium in the system, still more doubt may be expressed. The administration of the calcium salts (especially calcium lactate) has in some cases overcome the convulsive tendency, while in others there has been no effect whatever (Haskins and Gerstenberger).[3] In the case of Haskins and Gerstenberger no disturbance of

[1] Die Tetanie der Kinder, Vienna and Leipzig, 1909.

[2] Riv. d. Clin. Ped., 1920, xviii, 577.

[3] Jour. Exp. Med., 1911, xiii, No. 3.

calcium was present. Reiss[1] thinks that the condition is due to a disturbance in the relation between the calcium and magnesium on the one side and sodium and potassium on the other. While in his earlier investigations[2] the writer was unable to find definite evidence of a variation in the formula $\frac{Ca + Mg}{Na + K}$, later investigations[3] give some encouragement to further procedure in this direction.

Howland and Marriott,[4] Denis and Talbot,[5] and Jacobowitz[6] have all demonstrated a definite reduction in the calcium content of the blood. Handovsky[7] was, however, unable to show that the facial phenomenon was accompanied by any such reduction. As already stated, Orgler[8] found that calcium oleate was much better dissolved in the blood serum than calcium phosphate. Maggiore[9] and Brown, MacLaughlin and Simpson[10] have both demonstrated that injection of calcium intravenously reduces the electrical irritability. The latter writers, however, regard this as a dangerous procedure. Schiff[11] found that subcutaneous injection of magnesium sulphate, as suggested by Behrend, was followed by correspondingly high excretion of calcium. Schiff and Stransky[12] showed that such

[1] Zeitschr. f. Kinderheilk., 1911, iii, 1.
[2] Amer. Jour. Dis. of Child., 1913, v. 205.
[3] Am. Jour. Dis. Child., 1917, xiii, 44.
[4] Quart. Jour. of Med., 1918, xi, 289.
[5] Am. Jour. Dis. Child., 1921, xxi, 29.
[6] Jahrb. f. Kinderheilk., 1920, xcii, 256.
[7] Jahrb. f. Kinderheilk., 1920, xci, 432.
[8] Jahrb. f. Kinderheilk., 1918, lxxxvii, 459.
[9] La Pediatria, 1919, xxvii, 129.
[10] Am. Jour. Dis. Child., 1920, xix, 413.
[11] Jahrb. f. Kinderheilk., 1920, xci, 43.
[12] Jahrb. f. Kinderheilk., 1920, xciii, 205.

injection impaired the calcium retention and that the calcium excretion through the urine was markedly increased.

Liefmann[1] has shown a distinct increase in acetone excretion in the urine during the manifestations of spasmophilia, but was able to determine no parallelism between the height of the acetone excretion and electric and mechanic irritability.

From the action of the various salts on the infant's organism and on that of animals, our suspicions are directed strongly toward that portion of the food. It is a well-known fact that to a degree the action of certain of these is antagonistic to that of others. It is, therefore, not at all improbable that the condition may be due to a disturbance in the relative amounts of these in the tissues. The whole subject is so indefinite that we may draw no conclusions which will give us definite indications for dietetic treatment. Brown and Fletcher[2] think that the condition is due to the accumulation of water in the tissues; this holds the sodium and potassium salts. They believe that this "is brought about by the feeding of improper foods composed of high carbohydrates which have been subjected to heat." Gerstley and Hoskins[3] have found that hunger has some effect upon the electrical irritability, and Resch[4] found that irritability of the peripheral nerves to the galvanic current was produced by paraoxyphenolethylamine and hypophysin.

Symptoms.—The presence of the convulsive tendency is

[1] Jahrb. f. Kinderheilk., 1913, lxxvii, 125.
[2] Am. Jour. Dis. Child., 1915, x, 313.
[3] Am. Jour. Dis. Child., 1918, xv, 336.
[4] Jahrb. f. Kinderheilk., 1917, lxxxvi, 294.

shown by the increased electric irritability. For testing this a milliampèremeter is necessary which will register to fractions of a milliampère. A galvanic current is used. One electrode is placed on the abdomen, the other just above the crease of the elbow over the median nerve (or on the leg over the peroneal nerve). The amount of current necessary to produce the slightest twitch of the index-finger (or great toe) is then recorded. The cathode-closing contraction may be reduced. Most typic, however, is the cathode-opening contraction. Where this is produced by less than 5 ma. of current it may be regarded as pathologic; over 5 ma., as normal. The anode-opening contraction is produced by less current than is the anode-closing contraction.

Clinically, this hyperirritability may remain latent for some time, in fact, may never be accompanied by clinical symptoms, but usually at some time or other these develop. They usually appear in one or more of four forms: convulsions, carpopedal spasm (tetany in the restricted meaning of the term), laryngospasm, or rotary head spasm.

The spasmophilic *convulsion* is chiefly characterized by its tendency to repetition (as many as seventy convulsions in twenty-four hours being noted) and by the frequent serious involvement of the respiratory muscles. It is frequently accompanied by the peculiar crow characteristic of laryngospasm. *Laryngospasm* is of common occurrence, and though alarming, is not serious, except in so much as it shows the disposition toward general convulsive seizures. Carpopedal spasm and rotary head spasm are rarer manifestations of the condition.

It is rather interesting to note here that Morse[1] found no epilepsy developing following spasmophilic convulsions.

Treatment.—As an assistance to dietary treatment, attention to the hygienic surroundings is very important. Fresh air is very necessary. These infants should never be kept in hot, poorly ventilated rooms, nor should they be allowed to remain dirty.

It is a well-known fact that a purely carbohydrate food decreases the convulsive tendency, but this cannot be continued for more than a few days without serious disturbance of the infant's nutrition. It is, therefore, necessary to give milk or other food. In these cases the writer has applied a parallel treatment to that outlined for intoxication. The curds of milk are suspended in arrow-root-water and given in about the amounts specified there. In the spasmophilic diathesis it makes no difference whether the curds from skimmed milk or whole milk are used. It is obviously better, therefore, when the nutritional disturbance is only slight to use the curds of whole milk. In several cases there has been a distinct cessation or betterment of symptoms on this food, with a regular return to their former intensity when whey was added. After carefully studying several cases the writer is convinced that before a certain period in the convalescence is reached, the addition of whey to the food increases the tendency to convulsive seizures in many cases. It is very hard to explain this action from our present knowledge of the etiology of the spasmophilic diathesis, but it may be that the calcium is absorbed in relatively greater quantity than the sodium and potassium, since the latter are materially reduced in

[1] Am. Jour. Dis. Child., 1919, xviii, 73.

the curd mixture, while the former is not so markedly affected. It should be noted here that Zybell[1] was able to determine no regular effect of changes in diet on electric irritability in spasmophilia. He has used, however, different material from that of all other writers on the subject. Berend[2] has obtained excellent results by injecting subcutaneously an 8 per cent. solution of magnesium sulphate. This is given in amounts of 15 to 20 c.c. and repeated in a few hours if thought advisable. Usually, however, one injection a day is sufficient. Klose[3] had excellent results in reducing the acute symptoms by this method. In view of the recent discovery that injection of magnesium sulphate is accompanied by excretion of calcium, one may question whether it is wise to employ it, however. The best routine results obtained by the writer have been with calcium lactate, grs. xxx every four hours. This should be continued for weeks.

Finkelstein has shown that cod-liver oil and phosphorus gradually but surely reduced the electric irritability. This should be given to the amount of 1 teaspoonful of cod-liver oil containing $\frac{1}{200}$ grain of phosphorus three times a day. Since, as Schabad[4] has shown, cod-liver oil probably increases the retention of calcium, it is possible that the benefit obtained from their use in the spasmophilic diathesis may be explained in this way.

For the acute convulsions it is frequently necessary to use sedatives. The best of these is chloral hydrate. This

[1] Jahrb. f. Kinderheilk., 1913, lxxviii, Erganzungsheft, 29.

[2] Monatsschr. f. Kinderheilk., 1913, xii (Orig.), 269.

[3] Monatsschr. f. Kinderheilk., 1916, xiii, 517.

[4] Monatsschr. f. Kinderheilk., 1911, x, 12.

should be given rectally, 1 to 2 grains in 1 ounce of water. In order to control the condition at first 2 to 3 grains are usually sufficient, though it may require as much as 5 grains in a child over a year old. After the initial dose 1 grain every four hours is nearly always enough to keep the convulsions under control. One should never cease the use of this abruptly, but should gradually lengthen the interval between doses. At times, where quick action is necessary and the convulsions are very severe, it is necessary to use morphin or even chloroform. To arouse the child from a generalized convulsion which has especially affected the respiratory muscles, dipping it from a tub of cold water to a tub of hot water will often stimulate respiration sufficiently so that if frequently repeated the life will be eventually saved.

CHAPTER XXI

THE NERVOUS INFANT

A NERVOUS infant is one which reacts with abnormal acuteness to external stimuli, especially to those directed toward the higher cerebral functions. Some slight inconvenience may produce a spell of crying or the crying may be unusually prolonged or intense. Again, the laugh may be excessive. The slightest cry or laugh may produce vomiting, or after a day of severe nervous stress the number of stools may be increased.

There are undoubtedly many congenitally neurotic infants, but the most evident form is seen only in those where the condition has been augmented by spoiling the child with the attentions of fond parents or guardians, and also (not infrequently a result of the same attitude) the disturbance of the nutrition from overfeeding. These infants are the most prone to cry, and they are, therefore, the most apt to be petted. This constitutes the vicious circle, which must have its effect not only on the psychic, but also on the physical, condition.

When these infants become sick, it is very hard to judge just how much of the clinical picture is due to the neurotic condition. For instance, the newborn baby suffering from undernourishment shows very little tendency to loud crying, but should this child be neurotic, it is difficult to determine whether or not the cry is from hunger or from colic.

Occasionally an infant vomits or, rather, "spits up" some of its food, even though this be of such a composition and amount that we are certain in the given case that it is not irritating to the stomach. This child is almost certain to show other neurotic symptoms. These and many other circumstances, such as starting at the slightest sound, restlessness in bed, etc., might be mentioned.

All these symptoms are exaggerated by nutritional disorders of the less severe kind, as weight disturbance and dyspepsia. Two articles of food seem to be especially active in increasing the nervous symptoms—the fat in fat constipation and the sugar in dyspepsia. In the breast-fed infant the most frequent cause of nervous manifestations is irregular and frequent nursing, whether these produce colic or not. Nutritional disturbances are most active in accentuating the nervousness, and, as in so many other conditions of infancy, the diet, therefore, assumes prime importance, not in so much as to give a specific treatment, but rather in a prophylactic way, by preventing nutritional disturbances and hence nervous symptoms.

Treatment.—*Regularity* in all the activities of the infant is perhaps the most important thing in the treatment of the nervous child. The food should be given at a set time each period. The child should be taught to sleep at a certain time each day. The stool should, as far as possible, be passed at the same hour. The bath should be given and the infant weighed in the morning at the same hour. Absolute regularity, with no undue excitement caused by the active admiration of so-called friends and overfond parents, is very necessary to the comfort of the nervous

child. All these act by resting the mind and steadying it with a daily invariable routine.

Fresh air is most beneficial. A child which is cross and fretful in the house will frequently sleep soundly if put in the open air. This is especially true if the weather is cool. An out-door life, with sleep out-of-doors except in extreme weather, is a splendid tonic for the nervous infant. Strict attention should be paid to the bath and cleanliness. A wet diaper will not infrequently be the cause of a severe crying spell.

As previously stated, the *diet* should contain little of fats or sugars, certainly not enough of these to produce even slight nutritional disturbances. Starches are well taken care of and have no irritant action. In the infant over a year old, cereals and vegetables should form most of the food, the milk being reduced to 1½ pints a day and no eggs or meat being given. The most essential thing is to prevent nourishment disturbances by properly dosing the food.

Drugs should never be given in the form of tonics, and should only be used when acute conditions absolutely demand them.

CHAPTER XXII

INFANT FEEDING IN RICKETS

In spite of the fact that the clinical picture of rickets is very clearly marked and that the condition is such a common one, there has never been a satisfactory explanation of its cause. Is it, like the exudative diathesis, the spasmophilic diathesis, and the neuropathic taint, a predisposition which develops its active symptoms only under adverse conditions, or is it the result of some product of metabolic or bacterial origin which acts upon an organism which from the standpoint of inheritance is normal? Is improper diet the cause of rickets, or does it only influence the degree of the clinical picture? Five possibilities present themselves: first, that rickets is a chronic specific bacterial infection; second, that it is the result of a low-grade chronic toxemia, probably caused not by any one bacterium, but by a number of various infections; third, that it is a metabolic disturbance due to the excessive or deficient absorption of certain elements of the food; fourth, that it is the result of a deficiency, or disturbance in secretion, of some one or more of the ductless glands (suprarenal, parathyroid); fifth, that it is due to some inherited predisposition which is distinctly influenced by the state of health in extra-uterine life.

The first of these hypotheses has been practically abandoned by modern pathologists and pediatricians. The second is supported by such an eminent man as Marfan,[1]

[1] Sem. Med., 1907, xxvii, 469.

who thinks that the rachitic bone findings and other pathologic changes can best be explained as the result of chronic intoxication, whether this be due to syphilis, tuberculosis, or gastro-intestinal disturbances. This theory is supported by the work of Iovane and Forte,[1] who produced changes in rabbits almost identical to those of rickets by injection of alcoholic and aqueous extracts of the feces of rachitic infants (with and without gastro-intestinal disturbances). Many points seem to favor this view, but, of course, dietetic errors and congenital predisposition cannot be discarded as possible factors even here.[2]

That a metabolic disturbance is present may be regarded as proved, but that this disturbance is due to improper food may be questioned. It is a very noticeable fact that the severest forms of inanition in early infancy rarely show distinct rachitic changes, nor do they develop them later; nor is there a greater tendency to the development of rickets in these children than in normal children of the same age. There is a widespread impression in America that if an infant be fed a food rich in fat it will not develop rickets. From a clinical standpoint this is not true, nor is there any scientific reason for believing that it should be true. Widmer[3] suggests that the condition is due to an overflooding of the system with water, while Finlay[4] thinks that there is a very definite relation between rickets and the air-space in which the infants live.

[1] La Pediatria, 1907, v, 641.

[2] For a complete discussion of the metabolism of rickets, see Orgler (Ergeb. f. inn. Med. u. Kinderheilk., 1912, viii, 142) and Meyer (Jahrb. f. Kinderheilk., 1913, lxxvii, 28).

[3] Jahrb. f. Kinderheilk., 1916, lxxxiii, 177.

[4] Lancet, 1915, clxxxviii, 956.

Recently much has been written regarding the rôle played by fat soluble *A* in the production of rickets. Mellanby[1] has carried on some experiments which were very suggestive. His findings have been substantiated by other writers. The recent metabolic experiments of Freise and Rupprecht[2] were interpreted by these investigators as indicating that favorable calcium and phosphorus balances by the use of fresh vegetable juices are due to some substance in these juices resembling the vitamine. Findlay,[3] however, advises caution in accepting definitely the fat soluble *A* as the cause of rickets, and it seems to the writer that such caution is advisable. Hess and Unger[4] could find no evidence that rickets was caused by a deficiency of this vitamine.

Many investigators have shown that there is a deficiency of calcium in the system in cases of rickets. Schabad[5] has demonstrated that in rachitic infants cod-liver oil promotes the absorption and retention of calcium, and thus its well-known beneficial effects are explained. On the other hand, we know that a food rich in fat very frequently produces a fat constipation in which calcium is withdrawn from the system. The action of cod-liver oil, therefore, cannot be generalized to include all fats, but must be regarded as the property of that form of food. The action of cod-liver oil in promoting retention of calcium is markedly increased by the addition of phosphorus and calcium acetate (Schabad). There is no parallelism between the severity of the rachitic symptoms and that of the nutritional disturbance.

[1] Lancet, 1919, i, 407.

[2] Monatsschr. f. Kinderheilk., 1920, xix, 115.

[3] Arch. of Ped., 1921, xxxviii, 151.

[4] Jour. Am. Med. Assoc., 1920, lxxiv, 217.

[5] Jahrb. f. Kinderheilk., 1910, lxxii, 1.

Fig. 28.—Severe rickets, showing marked thoracic deformity.

Rickets certainly occurs less commonly in breast-fed infants; so it is fair to assume that there is a relation between rickets and the character of the food. What this relation is we do not know, further than to state that overfeeding and improper feeding distinctly increase the degree of the rachitic process. As yet we know no food, not even breast-milk, which will insure against the appearance of rickets. In the city of Chicago in the last few years the writer has seen no fewer than 500 negro babies between the ages of six and eighteen months. No one of these has been free from rachitic symptoms and bone changes, although many showed no gastro-intestinal symptoms and were fed carefully on the breast. This simple fact would seem to speak strongly against the theory that rickets is caused by poor feeding.

The theory of Stoltzner,[1] that rickets is caused by a deficiency in suprarenal secretion, has found few adherents and is lacking in substantiation by facts. The effect on the gnawing teeth of rats by removal of the parathyroid gland has been shown by Erdheim,[2] and is suggestive, as are the metabolic experiments demonstrating the increased excretion of calcium in parathyroidectomized dogs (MacCallum and Voegtlin).[3]

In support of the theory of congenital predisposition, it may be said that the occurrence of rickets in children raised under normal conditions suggests that there must be something more than acquired disturbances to account for this. There is some question whether rachitic symptoms are

[1] Pathologie und Therapie der Rachitis, Berlin, 1904.

[2] Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1906, xvi, 632.

[3] Jour. Exp. Med., 1909, xi, 118.

present at birth or not. Kassowitz[1] brings much support to his theory of congenital rickets by his recent examinations on newborn infants, but as to whether or not one regards this evidence as conclusive can in no way affect the status of a congenital predisposition.

Schloss[2] has taken up exhaustively the question of rickets and finally comes to the conclusion that there are many factors which enter into consideration. It is rather interesting to note here that Niemann,[3] in examining the excretion of ammonia in the urine, found that in rachitic infants in contra-distinction to the normal, if fat were added to the food and carbohydrates taken away the ammonia content of the urine was increased.

In a physical way rickets influences the action of the stomach and intestines by producing an atonic condition of the intestinal musculature. This, in turn, produces a marked tendency toward constipation. Marked deformities of the chest compress the lungs, so that the oxygen supply to the tissue is insufficient and a deficient nutrition develops. Such extreme deformities are not common.

Dietetic Treatment of Rickets.—Though one can offer no assurance that rickets will not develop, no matter how carefully or under what conditions the infant may be brought up, still there is no question but that by careful attention to the rules of feeding and hygiene a severe rickets can almost invariably be prevented. There is no indication to give a food rich in fat in order to prevent the appearance nor to

[1] Jahrb. f. Kinderheilk., 1912, lxxvi, 369.

[2] Ergeb. d. inn. Med. d. Kinderh., 1917, xv, 55.

[3] Jahrb. f. Kinderheilk., 1917, lxxxv, 210.

alter the course of rickets, but each child should be studied as to his individual needs and fed accordingly.

After rickets has developed, the same attention to the individual case must be observed. In addition, cod-liver oil (in the form of an emulsion or plain) should be given. In giving this, one should be careful not to give too much and not to give it at all in hot weather. In autumn, winter, and spring one should never give over 1 teaspoonful three times a day, while during the cooler days in summer a teaspoonful morning and evening is usually all that can be given with advantage. One should always remember that cod-liver oil is a food, and must be reckoned with in estimating the total food value. To the cod-liver oil it is well to add phosphorus to the amount of $1/200$ grain to the dram dose (ol. morrh., 100; phosphori, 0.01). Schloss[1] advises the addition of tri-calcium phosphate to the cod-liver oil.

Hess and Unger[2] have used cod liver oil as a prophylactic in negro babies with excellent results.

[1] Jahrb. f. Kinderheilk., 1915, lxxxii, 435; ibid, 1916, lxxxiii, 46.

[2] Jour. Am. Med. Assoc., 1917, lxix, 1583.

CHAPTER XXIII

INFANTILE SCURVY

SCURVY (Barlow's disease) is a rather uncommon affection, which is seen more frequently among the middle and wealthier classes. Its pathology consists in a marked tendency to hemorrhage, which is most frequently found primarily beneath the periosteum of the long bones. The bone portions most affected are the lower end of the femur and upper end of the tibia. These give the characteristic tenderness on pressure and the condition peculiar to this disease, in which the child is happy when allowed to lie still, but cries when moved. If the teeth have pierced the gums there are frequently small hemorrhagic pouches about their bases.

Hess[1] has described a condition which he characterizes as latent scurvy which is characterized by increased pulse and respiratory rate. Much has been written lately concerning the relation of vitamines to infantile scurvy. It seems very likely in view of the investigations of Hess[2] and others that there is a water soluble vitamine, the deficiency of which in the food is responsible for the occurrence of scurvy. This substance is destroyed or materially reduced by long heating of the milk. Especially is this true in the process of pasteurization; while boiling the milk reduces, to a certain extent, the anti-scorbutic factor, it does not seem to

[1] Jour. Am. Med. Assoc., 1917, lxviii, 235.

[2] Am. Jour. Dis. Child., 1919, xvii, 221; 1917, xiv, 337.

have as profound an effect as does pasteuriaztion. Other factors enter here also. Cows which have been fed on brewery refuse seem to give a milk which is low in antiscorbutic vitamines, and milk which has stood for some time is in a similar condition. It is stated by Hess that this anti-scorbutic factor may be killed by the preservation of milk with hydrogen peroxide. Gersternberger[1] has found an anti-scorbutic factor in malt soup which is prepared from fresh barley. Faber[2] has reported a case of scurvy which he attributes to the long continued use of sodium citrate. It has been thought for some time that alkalies tended to reduce the anti-scorbutic vitamine.

In connection with infantile scurvy the metabolic findings of Lust and Klochmann[3] and Frank[4] are exceedingly interesting. They found no variation in the nitrogen metabolism from normal during the florid stage; there was, however, greater retention of calcium, phosphorus and chlorin than in the normal infant, while during the stage of convalescence there was a negative balance of these salts which, after some weeks, came back to normal.

Treatment.—To prevent this disease would probably be very easy in most cases if we knew that there was a tendency to scurvy, but since it is obviously impractical to order orange-juice for all babies, and there is some doubt as to the advisability of so doing, prophylaxis is a rather difficult matter. The response to treatment is so immediate in most cases that it is also rather unnecessary.

[1] Am. Jour. Dis. Child., 1921, xxi, 315.
[2] Am. Jour. Dis. Child., 1921, xxi, 401.
[3] Jahrb. f. Kinderheilk., 1912, lxxv, 663.
[4] Jahrb. f. Kinderheilk., 1920, xci, 21.

Active treatment consists, in the youner infants, in the administration of orange-juice. This is best given between feedings, to the amount of about 2 to 3 ounces a day. In older children orange-juice may be given in the same amount, or baked potato, about 4 to 6 level tablespoonfuls a day. Givens and McClugage[1] have found that orange-juice dried in the proper way retains its anti-scorbutic properties for at least three months.

The results from this treatment are very rapid. In the case of medium severity, four days is usually sufficient for the disappearance of all symptoms, while in very severe cases as long as two to three weeks is necessary.

The diet should be changed, if the child is on denaturized food, to a suitable mixture for the given case. If the food has not been boiled, evaporated, etc., and no gastro-intestinal symptoms have developed, it is unnecessary to change it at all.

During the first weeks after the disappearance of the symptoms it is well to give as much as ½ ounce of orange-juice daily. Hess[2] suggests the use of potato water instead of barley water as a diluent. He[3] found that the pericarp of wheat added to the diet produced a prompt amelioration of symptoms, but that its action was not so rapid as that of the fruit juices. Freudenberg[4] and Freese[5] have had success with the alcoholic extract of vegetables.

[1] Am. Jour. Dis. Child., 1919, xviii, 30.

[2] Am. Jour. Dis. Child., 1914, viii, 385.

[3] Jour. Am. Med. Assn., 1915, lxv, 1003.

[4] Monatsschr. f. Kinderheilk., 1914, xiii, 141.

[5] *Ibid.*, 1914, xii, 687.

CHAPTER XXIV

INFANT FEEDING IN ECZEMA

In the infant we see two distinct types of eczema: the moist eczema, which occurs nearly exclusively in fat, flabby, pale infants; and the dry eczema, which is found with almost the same regularity, only in thin, marantic infants.

The former of these is intimately associated, as a rule, with other signs of exudative diathesis. It is usually most marked on the cheeks and is often accompanied by a seborrheic eczema of the scalp. The dry eczema is most likely to be found about the front of the thorax and over the shoulders.

Concerning *metabolism* in these cases little is known. Aschenheim[1] has shown that the assimilation boundary for sugar (especially maltose) is low, and that food rich in carbohydrates often leads to the appearance of sugar in the urine. Freund[2] has shown a marked tendency to water retention.

From these findings we would conclude that the carbohydrate (especially maltose) was that food-stuff which should be eliminated from the food if we wish to get the best results, both because of the apparent inability of these infants properly to assimilate this and because of the known

[1] Discussion in Monatsschr. f. Kinderheilk., 1909, viii, 425.

[2] Cited by Moro, von Feer's Lehrbuch der Kinderheilk., Jena, 1911, 669.

tendency of carbohydrates in general, and sugars in particular, to promote water retention.

Clinically, the removal of water from the system, as, for instance, by a severe diarrhea, is immediately followed by a distinct improvement of the eczema.

Although all metabolic data up to the present time point to the fact that the carbohydrates are disturbing in cases of eczema, clinical experience runs distinctly counter to this, and shows that, while the starches are taken care of with advantage, it is the fat which is the chief source of difficulty and the amount of which must be carefully dosed.

In the breast-fed infant, if lengthening of the interval between nursings to four hours and temporary shortening of the time at the breast are not sufficient, it is necessary to substitute for one breast nursing a feeding of carbohydrate, usually some starchy food like oatmeal, barley, or some other cereal, sweetened with a little milk- or malt-sugar. It is necessary to continue this treatment for some weeks or months if any permanent results are to be obtained. The eczematous condition may show improvement within a few days, but it is usually many weeks before anything resembling a cure is obtained.

In the artificially fed baby we must distinguish in our treatment between the fat, flabby, overfed infant and the poor, puny, marantic child. In the former the error in diet has nearly always been a food too rich in fat. The indication for treatment in these cases is clear—reduction of the fat and substitution of carbohydrates. On the other hand, we must be careful not to give a fat-free food over too long a time, because the condition of starch overfeeding is much more to be dreaded. If we must decide in a chronic

case between a moderate amount of fat in the food with eczema and a fat-free food without eczema, we must always choose the former. For since the eczema in itself is only an annoying, but not a serious, disease, we must pay attention first to the general health of the child and only secondarily to the eczema.

Finkelstein[1] advises the use of a food prepared in the following way: To 1 liter (quart) of milk is added 1 teaspoonful of pegnin (a rennet ferment), the whole heated to 42°C. (107.6°F.), and kept at that temperature for one-half hour. The coagulum is then separated from the whey and made into a ball. This is allowed to drain through a linen sack until it is free from every drop of whey. The whole is then finely divided, 200 c.c. (about 7 ounces) of whey are added, and the whole put through a sieve with barley-water sweetened with 1 tablespoonful of sugar, the whole being made up to 1 liter (quart). This mixture is not to be used in infants under one year, emaciated infants, nor those suffering from nutritional disturbances. The writer has had no experience with this preparation.

In those cases of chronic malnutrition complicated by a dry scaling eczema, it is dangerous to attempt any measures directed against the eczema unless full account is taken of the general condition of the infant. Most of these cases require that our efforts be directed toward the general nutrition. It not infrequently happens that if this can be brought up to normal the eczema will disappear.

One should never be too sanguine as to the results to be obtained with any treatment in infantile eczema.

After having tried most of the suggestions as to dietetic

[1] Med. Klin., 1907, ii, 1098.

treatment in eczema, the writer has come to the conclusion that the eczematous process is very little influenced by diet provided the fat content is not too high. He is strongly of the opinion that the condition is more influenced by the removal of external irritants than in any other way and that both the application of ointments and regulation of the diet are essentially secondary factors.

CHAPTER XXV

CONGENITAL PYLORIC STENOSIS AND PYLOROSPASM[1]

These two conditions are so distinctly associated in a clinical way that it is necessary to consider them together. The congenital pyloric stenosis is a thickening of the muscular coat of the pylorus; the pylorospasm, as the name implies, is a state of spasm of the pylorus. Both are characterized by uncontrollable vomiting and by appearance of reverse stomach peristalsis in the epigastrium.

Etiology.—Primarily, the question to be settled is as to whether either or both of these conditions are congenital in origin. The true pyloric tumor has once been found postmortem in the fetus (Dent).[2] It is hard to conceive of the formation of such a mass in the first two weeks of life, and if, as some think, the condition is due to spasm of the pylorus, then one would certainly expect to find a tumor present in all cases of pylorospasm. The mere hypertrophy of the pylorus does not mean in itself stenosis. It is possible that this hypertrophy exists at birth, and that the normal stomach secretions and contents cause in such an hypertrophied muscle a distinct overaction, the severity and extent of which varies in different cases and requires a different length of time to develop. This would explain the fact that some

[1] An excellent monograph is that of Hertz. "Studien over den Medϕdte Pylorusstenose hos spaede Bϕn," Copenhagen, 1915.

[2] Quoted by Miller. (See later.)

cases manifest themselves almost immediately after birth, while others appear later.

At present, evidence points strongly to a separation of this clinical picutre into two separate groups: the first, congenital in origin and characterized by a distinct hypertrophy of the pyloric musculature; the second, acquired and characterized by spasm of the pylorus. Whether pylorospasm is a congenital or acquired tendency is an open question. Most cases can certainly be regarded as acquired, since the symptoms do not manifest themselves until several weeks after birth. I have in mind one case, however, in which severe vomiting had existed every day without interruption from birth on, which on operation, at the end of the fourth month, showed no enlargement at the pylorus. Hess[1] has described other spasms such as pharyngospasm, cardiospasm, etc., which are so frequently associated with pylorospasm as to suggest a general tendency.

Both conditions are most often encountered in the first weeks of life. The stenosis usually appears before the sixth week. Most of the infants have been fed previous to the disturbance on mother's milk. It is not at all improbable that nutritional disturbances may play some part in cases of pylorospasm. Pyloric stenosis is more frequent in males and in the first born.

Pathology.—On opening the abdomen the *stomach* is usually found dilated; if contracted, the wall is thickened. If stenosis be present the *pylorus* is found of cartilaginous hardness and very much hypertrophied. Pfaundler[2] has called attention to the fact that in the "systolic" stomach

[1] Am. Jour. Dis. Child., 1914, vii, 184.

[2] Jahrb. f. Kinderheilk., 1909, lxx, 253.

the pylorus may be as large in circumference as in some cases of pyloric stenosis, but that in the latter the mass is more elongated and does not disappear when 50 to 60 c.c. of water is introduced into the cardiac orifice. Miller[1] states that sometimes the pylorus is found tucked in behind the pyloric portion of the stomach. The thickening of the pylorus tapers off more or less gradually on the stomach side, but ends abruptly on the duodenal side. On cutting through the pylorus the thickening is seen to be wholly in the circular fibers of the musculature, while the mucous membrane lies in deeper folds than is normally the case. Microscopically, there is seen only hypertrophy of the circular muscular coat of the pylorus.

The duodenum is white and collapsed in the advanced cases, and is so atrophic that it is frequently unable to perform its proper function after communication between it and the stomach is established. Some unimportant congenital anomalies of other parts of the body have been found.

Symptoms.—These usually begin very early in life, often before two weeks, and rarely after three months. The excessive uncontrollable vomiting and the constipation soon lead to extreme emaciation and frequently to death from starvation.

The *vomiting* is the most characteristic symptom, and yet in itself there is little that is distinctive except its persistence. It may be ordinary vomiting or it may be, and frequently is, projectile in type. It is never a simple regurgitation. It occurs more frequently a few minutes (fifteen to thirty) after taking food, but may not occur for several hours. The amount vomited is often more than

[1] The Medical Diseases of Children, Bristol, England, 1911, 260.

that ingested. It matters very little what the nature of the ingested food may be: even water is immediately vomited in the severest cases. As one would expect from the nature of the disease, the vomitus is never bile-stained nor fecal. Rumination is sometimes seen in pylorospasm (Aschenheim).[1]

The *stool* is very small and ribbon-like, but usually well digested. It is passed infrequently, once in twenty-four or forty-eight hours.

Subjective *nervous symptoms* are lacking. The children are usually contented, considering their general condition. Sometimes during intense peristaltic action there seems to be some discomfort. The *urine* is scanty.

Physical Signs.—When first seen these infants are *emaciated* and *pale*. In the more advanced cases a slight cyanosis is seen. They do not have the "sick" appearance of infants suffering with severe nutritional disturbances nor do they seem so discontented. Of course, they are weak and relaxed.

The physical signs of importance are those of the epigastric region. *Gastric peristalsis* is very active. The stomach is seen to bulge just beneath the costal arch, the peristaltic waves become gradually more and more manifest; finally, the stomach seems to assume a sort of hour-glass shape with a marked constriction in the middle. This constriction draws closer and closer to the pyloric extremity and then retreats, showing the antiperistalsis, which is often followed by an explosive attack of vomiting. One should not expect to see this whenever the child is examined. It usually requires constant watching over at least a half-

[1] Zeitschr. f. Kinderheilk., 1913, viii, 161.

Fig. 29.—Pyloric stenosis (Richter and Walls).

hour (frequently much longer) to get the typic peristaltic action. When the typic peristalsis is seen, there is no question of the presence of a hindrance to the passage of food from the stomach into the duodenum. No diagnosis of any such hindrance can be positively made unless the typic peristalsis is present in the epigastrium.

The next important physical sign is the palpation of a *tumor* in the region of the pylorus. If present, this is felt up under the liver just to the right of the median line. It gives the sensation which one has on feeling a rather deeply situated enlarged lymphatic gland, but the mass is, of course, harder to determine accurately and somewhat more movable. It seems to be about the size of a marble and is of rather hard consistency. The pyloric tumor, even if present, is not by any means always palpable. Perhaps in a certain number of cases this may be due to the posterior position of the pylorus as described by Miller. Its presence is almost absolute evidence, together with the gastric peristalsis, of an existing hypertrophic pyloric stenosis, but, on the other hand, failure to palpate such a mass does not necessarily mean that a hypertrophied pylorus is not present.

As to the chemical reaction in the *gastric contents*, many conflicting reports have been forthcoming, mostly because there has been no sharp distinction possible between pylorospasm and hypertrophic pyloric stenosis. It is certain that in a large proportion of the cases no change from normal has been noted, and that those cases which give the slightest physical signs usually give the most marked increase in acidity. Clark[1] found in pylorospasm two classes of cases—those with hyperacidity and those with hypo-

[1] Arch. Ped., 1911, xxviii, 648.

acidity. His results are especially reliable, since they were always carried out under the same conditions as to fluid used, time after ingestion, etc. Hess[1] found in most of his cases a profuse pancreatic secretion which contained an average amount of ferment.

Diagnosis.—The diagnosis is based upon the uncontrollable vomiting, the gastric peristalsis, and the palpable pyloric tumor. Continued vomiting without diarrhea in a young breast-fed infant, the interval between feedings being four hours, is very suggestive. This is more so if the infant vomits the water given between feedings. Such a history, coupled with emaciation, should lead one to investigate carefully the cause.

Diagnosis of these conditions can only be made if the peristaltic action of the stomach, as above described, is seen. Pylorospasm may exist without the presence of this peristalsis, but its presence can only be conjectured. This phenomenon will distinguish the condition from other forms of vomiting. It should, therefore, always be looked for if the vomiting is severe and continuous.

As to the cause of the pyloric constriction, it is more difficult to determine. Not only spasm and congenital hypertrophy can act in this manner, but also perigastric adhesions due to fetal peritonitis (Grulee and Kelly)[2] and polyp in the pylorus (Downes).[3] It is impossible to differentiate these conditions from a practical standpoint unless the presence of a congenital hypertrophy is made certain by the palpation of a tumor.

[1] Am. Jour. Dis. Child., 1912, iv, 205.

[2] Surg., Gyn., and Obst., 1910, x, 402.

[3] Surg., Gyn., and Obst., 1916, xxii, 251.

We should be careful not to misinterpret the abdominal findings. I have seen distinct peristalsis in a very transient attack of vomiting in a young, emaciated infant. The peristalsis, however, was not of the violent type found in pyloric stenosis, nor was there any antiperistalsis. This experience agrees with that of Hoffa.[1] Hess[2] is inclined to put less stress on visible gastric peristalsis and more on the state of the pylorus, as shown by the duodenal catheter. Whether spasmophilia can affect the unstriated muscle and produce symptoms closely resembling pyloric stenosis is a question yet to be solved. I have had 1 case under my care which strongly suggested such a possibility.

Prognosis.—This depends upon three conditions: First, the duration of the condition before treatment is begun; second, the nature of the underlying condition; third, the method of treatment. Very little dependence can be put on statistics, since there is such a wide variance in the opinion as to what constitutes pylorospasm and as to whether we can diagnose it without finding the gastric peristalsis. We, therefore, can form no definite opinion of those cases which have been treated by means other than operative. Practically all cases subjected to operation and reported have been so treated for congenital hypertrophy. Ibrahim[3] collected 136 operated cases, with a mortality of 55.1 per cent. Subsequent to this the writer[4] has been able to find reports of 20 cases with 6 deaths, a total of 156 cases with 82 deaths, a mortality of 52.6 per cent. In striking contrast

[1] Monatsschr. f. Kinderheilk., 1912, x, 533.

[2] Reported before the Chicago Pediatric Society, Dec. 16, 1913.

[3] Ergeb. f. inn. Med. u. Kinderheilk., 1908, ii, 270.

[4] Surg., Gyn., and Obst., 1910, x, 556.

to this general mortality stand out such reports as those of Downes[1] who in 31 cases in which gastro-enterostomy was performed had but 11 deaths and in 35 cases of Rammstedt operation 8 deaths. Strauss[2] has had only three deaths in 65 cases with the use of a slight modification of the Rammstedt operation. The prognosis of the individual case must depend as much upon the attending physician and surgeon as upon the condition of the patient. The judgement of one and the skill of the other must be a large factor in the success of surgical treatment.

Treatment.—The method of treatment is a very live question at present. American writers in general favor the surgical procedure, while German pediatricians are as strong in their belief in the dietetic treatment. Sauer[3] advises the use of a thick farina in the treatment of these cases. As to which of these is to be preferred the future must decide. The atrophic condition of the small intestine found in the advanced cases certainly speaks against delaying operation too long, and against final success in an obstinate case treated by dietetic measures.

Surgical Treatment.—Although many different operations have been employed up to the present time, that which has given the best results is the so-called Rammstedt's operation, a simple pyloroplasty. It is absolutely necessary in these cases that a skilled surgeon be employed and that the operation be done in the shortest time possible. Ether is the best anesthetic.

Postoperative Treatment.—After the operation it is often

[1] Surg., Gyn., and Obst., 1916, xxii, 251.
[2] Jour. Am. Med. Assoc., 1918, lxxi, 807.
[3] Arch. of Ped., 1918, xxxv, 385.

necessary to stimulate with strychnin or continuous saline enema. Water should not be given for from four to six hours. If at the end of this time water is retained, food in the form of teaspoonful quantities of mothers' milk or skimmed cow's milk should be given as often as every two hours. Very often at this time small quantities of albumin milk may be used to advantage. The amount can be increased and the period lengthened as rapidly as the infant's condition will permit. It is usually not necessary to keep the amount of food reduced for a long time, because when improvement once begins it is, as a rule, rapid. Vomiting usually continues for several days following operation, but is not violent in character and is suggestive rather of stomach irritation than of obstruction.

Dietetic Treatment.—Ideas as to the proper dietetic measures to be taken in these cases are very different. Heubner employs long intervals, with relatively large amounts of food, while Ibrahim gives small amounts at short intervals. Feer advises the use of skimmed breast-milk. It seems to the writer that if the diet is to be relied on, small amounts of food poor in fat given at long intervals should first be tried, and after that the amount increased, together with increase in the fat-content.

Medicinal and Other Measures.—Gastric lavage and gavage (Peiser)[1] is of much use in these cases, and should be often repeated if the infant is not in too weakened a condition. Use of atropin, grs. $\frac{1}{1000}$–$\frac{1}{500}$ hypodermically every four hours frequently aids greatly in overcoming a pylorospasm. Small doses of bromids may be given to quiet the general unrest and, to a degree, the peristaltic action. Opiates

[1] Monatsschr. f. Kinderheilk., 1914, xiii, 121.

may be used in the same way, but with more caution. Rosenstern[1] advises rectal enemas of sodium chlorid, 7.5 gm. (2 drams); potassium chlorid, 0.42 (3 grains); calcium chlorid, 0.24 ($1\frac{1}{2}$ grains); water 1000 c.c. (1 quart). In cases of hyperacidity this has been shown to decrease the amount of acid in the stomach. Sodium citrate has never given satisfactory results. Cowie[2] advises the use of antacids, provided their dosage is according to the amount of free acid in the stomach contents. Too much alkali, according to Cowie, closes rather than opens the pylorus.

From the indefiniteness of these instructions it will readily be seen that no measure, either dietetic or medicinal, has been sufficiently successful to meet with universal approval, and it is, therefore, fair to assume that the results are obtained not by the method employed, but by the judgment of the physician in the individual case. Overfeeding must be carefully avoided because it will only tend to exaggerate the condition. At the same time it is very difficult to make these infants retain sufficient quantities to preserve life.

To sum up the treatment of pyloric stenosis; after diagnosis is made it seems to the writer that the only method of procedure is operation. He has seen several deaths in cases treated by the thickened food method alone, and knows of other cases where this method was abandoned at the last minute and operation resorted to.

In the treatment of pylorospasm, the following procedure is one which he has followed in milder cases: atropine in the quantity of $\frac{1}{1000}$ to $\frac{1}{500}$ of a grain hypodermically is

[1] Deutsch. med. Wochenschr., 1910, xxxvi, 31.

[2] Am. Jour. Dis. Child., 1913, v, 225.

given 15 minutes before each nursing. If this is not sufficient to overcome the vomiting, stomach washing is resorted to. In the more severe cases this is done immediately before each feeding; in the milder forms once or twice in 24 hours. Where neither of these measures avail the child is given a thick paste, the stomach washings being discontinued but the atropine being given as before. The reason that the thick paste is not resorted to earlier is that it is not the food which may be regarded as filling the physiologic needs of so young an infant, and it is not continued any longer than seems absolutely necessary. This paste is made of a mixture consisting of farina or cream of wheat, milk and dextrimaltose, which is boiled down to the consistency required.

CHAPTER XXVI

INFANT FEEDING IN OTHER DISEASES

Acute Infectious Diseases.—There are no special rules in regard to the diet in this class of diseases. A simple reduction in the amount of food during the febrile period and the early part of convalescence is essential. One should always remember that nutritional disturbances are favored by the presence of these acute diseases and are to be treated as such. Chief among these is intoxication. It is very difficult to distinguish this from the disease itself in many instances. Diarrhea is frequently a symptom of the disease (as in typhoid fever), but more often it points to overfeeding. Vomiting is not common except in whooping-cough, in which instance much benefit can be derived from gastric lavage. It is not at all improbable that the mucus from the nasopharynx when swallowed may prove irritating to the intestinal tract, and that for this, too, lavage is of benefit. When a hyperpyrexia exists, barley-water alone should be given, but the supply of water should, under all circumstances, be kept up.

Tuberculosis.—In the miliary tuberculosis and tubercular meningitis dietetic treatment is obviously of no avail, nor does it seem possible by change of food to prevent the occurrence of the green mucous stool which is so frequently seen. Langstein[1] believes that he has lengthened the life of his cases of tuberculosis in infants by the use of albumin-

[1] Zeitschr. f. Kinderheilk., 1913, vii, 193.

milk. He lays stress on the importance of giving sufficient food, and believes that any tendency to vomiting will be bettered if large quantities are given every four hours, if necessary by gavage. From a diagnostic standpoint one should remember that miliary tuberculosis is characteristically accompanied by a diarrhea with four to five green mucous stools a day, and that this is in no way dependent on the character or the amount of food. Here, too, nutritional disturbances may occur, but the child can rarely be prevailed upon to take enough food to sustain life, hence disturbances due to excessive quantities are rare.

Scrofulosis is usually encountered not earlier than the last half of the second year. Contrary to the experience of most clinicians, the writer has had the best results in these cases with a carbohydrate-rich diet. He never employs cream and not over a quart of milk a day. The bulk of the food consists of vegetables and cereals. Of course, in all the cases the diet forms only part of the treatment.

Congenital Syphilis.—In the first two months of life in cases of congenital syphilis which have remained untreated there is often present a diarrhea with or without vomiting. In the typic uncomplicated cases there is no change of temperature from the normal, although the diarrhea may reach ten to thirteen watery stools a day. The stools are green and watery, as a rule do not contain mucus and curds, which, if present, are not characteristic. Without change of food when given proper antisyphilitic treatment the diarrhea stops in two to four days, the infant begins to gain weight, and in every way takes on the appearance and actions of a normal child of the same age. This

diarrheal condition is especially noticeable in breast-fed infants, but is by no means confined to these, and should always be thought of in cases with diarrhea during the first year of life, but more especially during the first two months.

In all cases of congenital syphilis, except those which do not respond to treatment (malignant forms, syphilis of the central nervous system, hydrocephalus, etc.), the diet should be regulated as is that of an infant under like nutritional condition without syphilis. Syphilis in itself, when treated properly and in the early months of life, does not affect the general nutritional condition to a noticeable degree. The same, of course, cannot be said of neglected cases, and yet in these the results of treatment are very surprising. There is no specific dietetic treatment for congenital syphilis, nor is any necessary. The general rules for diet in health and in nutritional disturbances hold here as in those infants not suffering with congenital syphilis, provided always that proper antisyphilitic treatment is effective. An apparent exception is in those cases where congenital syphilis has caused the child to be born prematurely, but in those cases it is likely that the syphilitic infection is so severe that it cannot be overcome by treatment, which condition can be regarded as a result not of the lowering of the infant's tolerance for food, so much as an overwhelming of the organism with the syphilitic infection. Cases of syphilitic hydrocephalus rarely show the proper reaction to food (*i.e.*, gain in weight, etc.), because of the cerebral involvement, and because on these cases treatment has little or no effect. But, as a general rule, we can say that if the clinical manifestations of congenital syphilis are prevented by treatment, the problem of

diet is not more difficult in the syphilitic than in the non-syphilitic infant.

In **congenital heart disease,** due to the lack of proper oxygenation of the blood in this condition, with the consequent deficient supply of oxygen to the tissues, there is usually seen a distinct state of malnutrition. This is not to be influenced by change in diet nor by any other means at our disposal. One must always be careful not to overfeed these infants, since their resistance is very low, and even a slight disturbance is likely to prove fatal.

Anemia.—Kleinschmidt[1] thinks that a large group of anemias in infants are of dietetic origin and advises even in young infants a diet in which vegetables and meat take the place of milk. Lederer[2] found that when milk is discontinued in the diet the water content of the blood is lowered and the spleen becomes smaller.

Anemia infantum pseudoleucæmica is not, so far as known, influenced by diet changes. The weight-curve is steadily downward until death occurs.

Respiratory Diseases.—*Nasopharyngitis* assumes special importance because of the mucus produced and swallowed. If we recognize that mucus is the chief medium in which the putrefactive bacteria act, we can see how this may produce nutritional disturbance. If possible the stomach should be washed frequently where the amount of mucus is such as to cause disorders. I have seen at least one case of continued vomiting as the result of irritation to the mucous membrane of the stomach from this source, which was greatly relieved by gastric lavage. The administration of

[1] Jahrb. f. Klnderheilk., 1916, lxxxiii, 97.

[2] Zeitschr. f. Kinderheilk., 1914, x, 451.

cod-liver oil in small doses (½ to 1 dram two to three times a day) is of much benefit in a large number of cases, but we must be very careful not to give so much as to favor vomiting.

In *bronchitis* cod-liver oil has an especially good effect. The total amount of food must be diminished before its administration or there is danger of nutritional disturbance. During convalescence the cod-liver oil should be continued and the value of the food gradually increased.

Bronchopneumonia requires a rather marked reduction of the food. Sometimes in this condition the weight tends to increase rather than diminish during the active stage, only to fall rapidly during resolution. This is due not to the food, but to the accumulation of exudate in the lung. In the subacute wasting types either breast-milk or albumin-milk offer the best means of keeping up the resistance.

Pyelocystitis.—In the early stages, when proper treatment is given, it is not necessary to change the diet further than a simple temporary reduction. When the condition has existed for some time a marantic state exists which is peculiarly resistant to dietetic measures. Probably the best means of treatment is to regard this condition as a severe case of decomposition on which is superimposed a pyelocystitis. Treatment for the latter must be continued and the food very cautiously dosed. It may take several weeks or months in the more severe cases to bring the infant to the state where it will react normally to food.

Pyelocystitis is often accompanied by diarrhea, and for this reason it is frequently overlooked and the gastro-intestina lsymptoms regarded as indicative of a severe

nutritional disturbance. The urine of all infants suffering from diarrhea with fever should, therefore, be carefully examined.

Cretinism, idiocy, etc., require no special diet. On the other hand, a cretin which has gone some time without treatment will often show a severe degree of malnutrition, which will respond to thyroid treatment and will gain weight rapidly without any change in diet whatever. As to idiocy, little can be said. Some idiots are remarkably well nourished, while others show quite severe states of malnutrition.

Otitis Media.—The fever requires that the food be reduced. After paracentesis the fever rapidly falls, and the proper food for the normal infant under the same conditions may be given. Otitis media is nearly always associated with nasopharyngitis, and, therefore, disturbance from the swallowing of mucus may occur.

Furunculosis.—Aside from the local treatment, the diet in these cases must be carefully watched. All nutritional disturbances should be avoided. Large amounts of fat or sugar in the food seem to favor continuation of the disease. The fat in most cases should not be removed entirely, because of its favorable effect upon resistance. In furunculosis the state of the nutrition is of paramount importance, and every means must be employed to prevent the occurrence of nutritional disturbances and to overcome such as exist. No special suggestions are necessary, since the disturbances encountered are those which have already been treated of in the chapters on the subject.

PART V

CHAPTER XXVII

PSYCHOLOGY OF INFANT FEEDING

No attempt will be made to go into the scientific consideration of this subject but only to detail a few of the writer's observations upon the practical side. No one who has had much to do with infant feeding will underestimate the importance of the psychologic element. In many cases it is the determining factor and is never left out of consideration, either consciously or unconsciously, by the physician in charge of the case. The physician has not only to deal with his own psychologic reaction and with that of his patient, but even more with the habits and tendencies of the patient's attendants. The relation therefore instead of being direct is indirect and consequently more difficult.

In considering the psychology of the infant we must look upon it from two standpoints, that of inheritance and that of environment. It is very difficult, in fact usually impossible, to distinguish how much is the result of one factor and how much the other. Nervous parents have nervous children, but there is so much difference between children of the same family frequently that it would be very hard to explain the different reactions of different members to the same condition. It seems more likely that environment, while an important factor, is not the only one. However this may be, all children are to a greater or less degree influenced by environment and since this is the only factor

which we can control, it is well to remember this point. Much stress has been laid in the foregoing pages upon regularity of life for the young infant. The importance of this rests not only upon the physical but perhaps to a greater degree upon the psychologic effect. Almost every physician has had the experience that a child not doing well in its home environment when taken to a hospital has shown marked improvement. The effect of psychologic processes upon physiologic symtoms is not well worked out in infants but enough is known to be able to show that much of the discomfort, frequently vomiting attacks and at times increased frequency of stools, may be due to the psychologic condition of the child. For instance, at the time when the baby is first being fed with a spoon, when it is often necessary to force feeding and there is frequently a refusal on its part to take cereal, the attempt to give a cereal is oftentimes followed by the vomiting of the complete feeding. That this is not due to any gastric irritation is proved by the fact that within a very short time this child is able to take the cereal, takes it with eagerness, and has no disturbance as the result. The more neurotic the inheritance and environment of the infant the more necessary it is to take these things into account and the more necessary it is to train the emotional side. It should be emphasized that training of the infant should begin at birth, not after the first year or second year. Habits are formed in the first two weeks of life which may be rather hard to break and the longer these are continued the more difficult or impossible the task becomes. It takes but a very short time for an infant to learn that if it cries it will be picked up and as a consequence it is not contented to lie quiet in its crib or

basket. This frequently happens even in the first two weeks of life.

Respect for authority should be cultivated at the earliest age. The only way in which authority can be appreciated by the infant is the discipline which is shown by a careful regulation of its life. This routine represents to it authority and its reaction is usually in proportion to the regularity with which this authority is asserted. The physician realizes better than anyone else what a serious thing the spoiling of an infant or child may become in case of illness and frequently this failure to recognize authority, because none has ever been asserted, results in a resistance to treatment which may be the turning point in a serious illness. But it is not only the failure to recognize authority, but the reaction which infants show to authority poorly asserted which may be of distinct disadvantage to their nervous systems. Authority imposed in a nervous irritable manner without sufficient firmness is frequently worse than no authority at all.

On the part of the attendants two tendencies stand out which frequently must be combatted. The first of these is the innate conservatism of the human race, the idea that what has been done before is right. The traditions which have been handed down from generation to generation are legion and each of them perhaps contains an element of truth, though, we must admit that frequently this is very effectively concealed. The grandmother nursed her babies whenever they cried, therefore, it is right that the mother should nurse this baby in the same way. No account is taken of differences in age and the memory of former feedings is usually clouded, but the ideas are expressed with a

dogma which can only be the result of ignorance and limited experience. Unfortunately, to combat such ideas the physician has not the scientific dogma which is convincing. He cannot state that in a given case if a certain thing is done there will be a certain result. He can only say that in 5 out of 6 or 99 out of 100 times if a certain thing is done there will be certain results.

One must always take into consideration the fact that there are always exceptions and that this case may prove the exception. No matter how deep his knowledge may be, the possibility of the exception is always present and he must remember that by the laity the exception is always quoted as the rule. Whatever his interest may be, the interest of the layman is in the individual case. Try as hard as we will the general public will never be educated to the ideas and ideals of the leaders of the profession, and not having the proper perspective they are not able frequently to interpret the ideas which are given them. We should never be too busy to explain the reasons for our instructions to the attendant of the infant nor should we be too busy to attempt to instruct this attendant in many of the circumstances that may arise. It is only by this individual and general instruction that we can hope to keep the public in a fairly rational state of mind regarding the subject. It is quite remarkable, however, how much has been done towards this end in the last ten years in this country, and I am inclined to think that this has been accomplished more by individual results obtained than by propoganda.

The second condition which we must meet is the attitude of the attendant toward the individual infant. This atti-

tude is very rarely that of cold judgment; it is in nearly every instance prompted by sympathy. This sympathetic attitude has unquestionably meant much to the human race, but like all other good things, it may be carried too far. I think there can be no question in the minds of anyone but that the tendency is now, and perhaps has been for several generations, to spoil the infant. Frequently the physician is regarded as cold and hard-hearted, especially by the grandmother, and oftentimes because of his insistance upon essentials in control of the environment his services are discarded for a less competent but more pliable man. We must remember that the layman has no standards which guide him in the choice of a physician except personal attachment and reputation. The former is certainly a very uncertain basis to use for the choice of a physician, and all of us know how undeserved many reputations are, especially if these be local.

The tendency frequently on the part of the attendant is to exaggerate trifles. Probably because of the nerve-racking atmosphere of modern life there is not the same tendency to disregard certain slight disturbances that there once was. A single instance in point—years ago colic was regarded as a normal state and every mother was rather disappointed if her baby did not have colic; now the pendulum has swung so far the other way that if a baby cries one hour out of twenty-four the mother is seriously disturbed and calls for immediate assistance. To a certain extent such an attitude is commendable because it enables us to attack conditions early and therefore get better results. But, on the other hand, over-anxiety on the part of the mother has a strong tendency to react by over-attention to the child.

On the part of the doctor the psychologic reaction is of the greatest value. No matter what his scientific knowledge may be in infant feeding, if he does not estimate properly the psychologic element involved he is very likely to be a failure in a given case. Not only must he estimate such element properly but he must be careful that his own reaction is as impersonal as possible. To one mother the strictest of rules will not be sufficient to produce results. To another mother such rules would perhaps result in a too strict supervision of the infant. One nursing mother in order to lead a natural and healthful existence must have a large amount of freedom; another must feel that she is sacrificing for her infant.

One great reason why there is so much more success in a given case in a hospital than in the home is that the physician is not hampered in anything like the same degree by the attitude of the attendants and as a result he can exercise much clearer judgment. He must, however, be sure that conditions in the hospital in which he is working are at least as good as they would be at home, that his assistants are loyal, and that their judgment is dependable; otherwise his cares are increased rather than diminished. How many times it happens to all of us that we accede to the request oft repeated of an indulgent mother although it is absolutely counter to our best judgment. None of us are proof against the continued entreaties but against these we must always be on our guard and try to weigh them, not by prejudice for or against, but in the judgment of our experience with like situations.

I have taken this opportunity to discuss this phase of infant feeding, not with the idea that I add anything to the

scientific knowledge of the subject nor that I have discussed it in anything like a complete manner, but simply to call to the minds of the profession the fact that infant feeding is not as yet a science but while it is based in large measure upon scientific facts, in individual cases we must take into consideration other than the physical factors involved.

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